Sol Skinnarland

Use of Progression Planning Tools in Developing Collaborative Main Contractor – Subcontractor Relationships in Norway

Doctoral thesis

Fafo

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Abstract

The research programme was designed to investigate the relationship between uses of progression planning tools and main contractor subcontractor collaborative relationships. The research was carried out within two Norwegian construction companies where collaborative progression planning tools and methodologies based on the Last Planner system of production control was used. The scope of the research was to test whether such uses could positively affect the collaborative relationships between the contractors and project participants on the construction site. Collaborative relationships in this research referred to a working climate of joint efforts to bring construction projects forward.

Literature claimed that adversarial relationships caused inferior productivity levels in the industry. Contractor relationships were assumed to influence how production processes were progressing. Thus developing collaborative relationships was assumed vital in order to improve productivity levels.

The DBA research was based on case-studies (observation and interviews) and a quantitative survey in the two construction companies.

Current research concluded that uses of progression planning tools may influence collaborative contractor relationships provided an equal attention is paid to structural and systematic approaches to collaborative planning, as to the social and relational dimensions, such as stimulating and motivating interaction and communication among project participants. The thesis provides detailed descriptions of the process elements. The study provides in depth insight into collaborative development processes in project based production settings.

The results may be valuable for researchers who aim to further advance knowledge of the importance of participant relationships in the field of construction management. The results may also be of value to construction managers who wish to emphasise the collaborative aspects of conducting projects.

Dedication

This thesis is dedicated to my family for their love and reason for being, and without whom the achievement of this thesis would mean nothing. It is dedicated to my mother Liv, and to my sister Inger Lise, my brothers Kyrre and Leif, and their families, and to the memory of my father, Kåre. And it is dedicated to Jenny.

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A completion of this thesis would not have been possible without the support and encouragement of many people.

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Glossary

Culture	The simple understanding of culture as shared among humans and expresses what we are, how we live our lives and what we do as a society.
Organisational culture	The unwritten rules of behaviour, of specific ways of acting and interacting within the organisation.
Collaboration	A working climate of joint efforts to bring a building project forward.
Collaborative culture	A trusting, working relationship between two or more equal participants involved in shared thinking, shared planning and shared creation.
Project culture	Shared values, basic assumptions and beliefs that participants involved in a project hold, that determine the way they process the project and the relationship with each other in the project environment.
Lean Construction	A collective term for philosophies, theories and practical planning tools related to site production in construction to improve the coordination and integration between actors and processes in construction, and in turn, enhance productivity performance.
LPS	Last Planner System®, a progression planning tool based on Lean Construction research, to control system realisation of plans.
Collaborative Planning	A planning methodology based on and adapted from the Last Planner System with dispersed responsibility to plan according to various time horizons.
Progression planning	Planning for future activities, with increasing levels of details closer to execution.
Progression planning tool	A methodology where people involved in the project are given responsibility to plan and to make ready tasks according to different time horizons. Thus the term tool in this research does not refer to a specific, technical tool, but, rather the structures, procedures and routines associated with collaborative planning.
Seven preconditions	Manning, space, preceding work finished, equipment, material, information (drawings) and external conditions.

Chapter 1 Introduction to thesis

1.1 Research significance

In many industries, such as advertising, biotechnology, computers, film and theatre, business is increasingly organised on a project basis (Lundin and Stablein, 2000). Also, construction work is organised as projects; as temporary collaboration between two or more business organisations (Jones and Lichtenstein, 2008, Kenis et al., 2009). In construction there is a growing tendency for subcontracts to replace direct work (Greed, 1997). Successful project delivery thus requires that all participants collaborate well and work together towards a common end (Reagle, 2008).

However, as pointed out by several authors (Egan, 1998), the construction industry suffers from less than optimal conditions that affect the industry adversely. It is fragmented (Porter, 1980), dominated by macho behaviour (Gale, 1992), and suffers from confrontational attitudes and a lack of trust and openness (Latham, 1994). There is a general agreement among academics and practitioners that the collaborative culture in this industry needs to improve, and the need for closer and less formal relationships within this industry is widely accepted (Jørgensen et al., 2004).

Over the last couple of decades, attempts have been made to address the challenges of fragmentation and poor collaboration, such as partnering agreements (Cox and Thompson, 1997)) and Lean Construction (Howell and Ballard, 1998, Ballard, 2000, Koskela et al., 2002, Eriksson, 2010, Andersen et al., 2012). Partnering agreements in general aim to facilitate team working, and Lean Construction philosophies and theories (Ballard, 2000, Koskela, 2000) seek to explain site production in construction, inspired by manufacturing principles first employed by the Toyota Motor Company (Shingo et al., 1989, Ohno, 1988, Womack et al., 1991). However, Lean Construction production concepts, developed over the last two decades, are founded on the specific characteristics of the construction industry. The Last Planner System (LPS) (Ballard, 2000) is a progression planning tool, which to date, is the most prominent tool to emerge from Lean Construction research. LPS is a project management tool, or more specifically a project management *methodology*, for increasing schedule predictability in design and

construction processes. The term tool in this research thus, does not refer to a specific, technical and tangible tool, but rather the structures, procedures and routines associated with LPS. Specifically, the progression planning tools, or methodologies, employed in this research were project kick-off meetings and phase schedule planning; meeting structures adapted to different time horizons; involvement of subcontractors ; use of electronic software products to visualize and communicate plan development and dependencies between trade specialists, such as Excel or Microsoft Project; use of milestones in planning; planned work zones; and facilities for involvement and collaboration in the construction projects.

The tools, or methodologies, employed in this research were derived from lean construction management literature (Ballard 2000; Bertelsen et al. 2007) and from previous research by the author in which LPS was implemented (Skinnarland and Moen 2010).

By involving key actors in the project supply chain from the outset of the construction project, LPS provides a system of work integration so that tasks may be completed when promised and to the right amount, quality and order. Lean Construction and The Last Planner System will be thoroughly reviewed in chapter 2.4.

1.2 Research aims and objectives

The empirical part of this research refers to Norwegian construction projects in which Lean Construction philosophy was utilised. The aim was to study how the use of collaborative progression planning methodologies, based on the LPS, may affect collaboration in the industry. Although the adversarial relationships described in the literature characterise the entire construction industry value chain, the scope of this research was to address the main contractor subcontractor relationship.

The core focus in this research was not on effects on production resulting from the use of Last Planner methodology, but rather on any effects on the collaborative relationship developing between contractors on the building site from being involved in planning and production. Thus the research question asked was whether the use of progression planning tools can be used to develop collaborative, main contractor subcontractor relationships in Norway. The study was based on practices of implementing joint main contractor subcontractor progression planning in Norway.

The results of this study may be of value both to theory and practice. Project managers and other practitioners may gain from insight into how such a methodology may

positively influence a much needed improved collaborative relationships. The study not only sought to state a link between the use of collaborative progression planning tools and development of collaborative relationships, but to go beyond to explore the processes of developing collaboration with the use of collaborative progression planning tools. The research also contributes to advancing the theory on project collaboration, by addressing how a main contractor subcontractor relationship may develop based on noted collaborative methodologies. A vast amount of authors in the field of construction management conclude their research and reports with an emphasised urgency with which collaboration needs to be improved (Egan, 1998). This research thus contributes to the knowledge base by addressing *how* this can be achieved.

The empirical basis for this research was two construction projects within two different construction companies in Norway. Both companies were selected on the basis of ongoing development programs in the two companies. They have both, over the last few years, implemented a collaborative planning methodology based on the Last Planner System (Ballard, 2000). This entails that people closest to production (team supervisors and trade workers) are given responsibility to plan in detail for the upcoming week, (thereof the term Last Planner). The middle (foreman) and upper management (project management) is in charge of planning for the next five – nine weeks, making ready tasks to be carried out when maturing into the (rolling) weekly work plan.

The main contractor project management team bring in subcontractor project managers and foremen/team supervisors as well as their own foremen/supervisors to plan jointly. This differs from a traditional approach to planning in the sense that the various trades would previously plan their own work which would to a less extent be coordinated with other trades' plans. The consequence of separate planning could be possible rework, poor quality, extensive waiting and so on (Ballard, 2000). The two Norwegian construction companies, by involving all (or at least many) of their subcontractors, have implemented and adapted the LPS methodology introduced above. A thorough description of the construction companies and their specific approach to the progression planning methodology is contained in appendix A, on page 210. A goal in this research has been to study how project management involve participants in progression planning, and thus a procedural approach has been equally important to the planning methodology itself.

A set of indicators were chosen, based on a review of the relevant literature, to represent and to operationalise collaboration in this study. Hence, research objectives were expressed in terms of functional relationships between the use of collaborative progres-

sion planning tools and the degree of a) familiarity and common goal setting; b) involvement and communications; c) conflict; d) motivation; e) awareness of each other's perspectives; and f) predictable working processes.

1.3 The salient areas of the knowledge base

Several theoretical attempts have been made to approach the challenges faced by this industry. The literature review introduces the main perspectives. Construction project management is increasingly analysed as supply chain management, as networks of actors that coordinate the efforts of the supply chain (Bowersox et al., 1999). Hult and Ketchen (2006) argue that the lack of a strong culture in supply chains necessitates a relationship guided by shared meanings to harness collective action. This may be particularly important in construction based on the interdependencies in the entire value chain (Vrijhoef and Koskela, 1999).

Scholars in strategic management have started to view supply chains as strategic. This also implies that the focus has shifted from 'firm vs. firm' towards 'supply chain vs. supply chain'. Strategic benefits are realised when recourses such as labour, transportation, equipment, facilities, tools, knowledge and capabilities tie supply chains closer together (Barney, 1991, Hult and Ketchen, 2006, Hult et al., 2004).

Another perspective on inter-firm relationships is the relational view. Collaborating firms can generate relational rents (Dyer and Singh, 1998); partnering agreements (Cox and Thompson, 1997) in construction serving as one example of a relational approach.

Still other researchers add to the understanding of project relationships by emphasising inter-organisational projects as a business strategy, specifically addressing interdependence and collaboration (Jones and Lichtenstein, 2008). A common thread among the different perspectives referred to above is the emphasis on interdependence, and pooling of resources between actors in a project.

1.4 Research methodology

The case study projects in this research have in common that they have adapted planning practices based on the Last Planner System methodology. Their adaptation is called "collaborative planning". Collaborative planning is a direct translation of the term LPS used by the Norwegian companies, and as such, both replaces the use of the

term LPS and constitutes an adaptation to LPS. Collaborative planning in this research means that project management involves most of the project participants; own employees and subcontractors, in the progression planning process (Skinnarland and Moen, 2010).

The research method employed was a case study, qualitative approach based on in-depth interviews with project managers, middle managers and team supervisors; focus group interviews (Bloor, 2001) with trade workers and apprentices; and observation in progression planning meetings. In addition a quantitative survey was carried out to establish functional relationships between uses of collaborative planning procedures and experienced effects on main contractor subcontractor collaborative relationships.

The interviews within the two construction projects were conducted at different points in time over a period of ten months. Progression planning meetings were assumed to constitute arenas for collaborative development, and thus observations looked for evidence of such behaviour.

A pilot study was conducted for exploratory purposes to inform the development and the later stages of this research. Two construction projects, one within each of the two participating construction companies, were selected for the case study. The pilot study stage also contained a survey carried out in four construction projects. The main purpose was to test the survey questionnaire and make subsequent improvements prior to the main study. The main case study was not carried out as a comparative study, however, choosing cases from two different companies offered more variation in terms exploring a wider set of experiences. The use of a pilot-study, a multi-project approach for the main case study, together with a triangulation of research methods employed, contributed to improved reliability and validity of this research.

1.5 Research assumptions

The current research was based on a few assumptions, which served as a point of departure in this research. First, it was assumed that improved collaboration in the construction industry was called for (Egan, 1998, Jørgensen et al., 2004), not only by academics in the construction management field, but also found to be desirable for practitioners in the industry. Following this assumption, collaboration, although some scepticism needed to be overcome, (see page 23), was assumed to be positive, which was also reflected in the definition of collaboration used in this research as a working climate of joint ef-

forts to bring the building project forward. Assuming a necessity for improved collaboration was based on reports showing inferior productivity levels in the industry (Andersen, 2004). Furthermore, it was assumed, that in order to improve production control by involving more project participants into progression planning routines and procedures, an implicit ambition among the participating construction projects was that relationships could be affected.

Second, current research assumed that collaboration in the main contractor subcontractor relationship was manageable through the use of progression planning tools. This assumption was based on previous research which reported improved collaboration through such use (Jørgensen et al., 2004, Skinnarland and Moen, 2010).

The third assumption was that the indicators of collaboration chosen in this research would provide indications for management on how to address collaborative development processes in their own companies. The indicators chosen for this research were aligned with a review of literature concerning changes towards a collaborative culture in different fields of research (Jørgensen et al., 2004, Johansen and Porter, 2003, Bohm, 1996, Habermas, 1991, Preece, 2004, Boland Jr and Tenkasi, 1995, Rommetveit, 1980).

1.6 Research limitations

All research studies have some limitations, as does this research. The case study approach makes it difficult to make causal conclusions since alternative explanations may always be found. This limitation stresses the concern for rigour of case study research to increase validity and reliability of findings and results (Yin, 1994). A concern for scientific generalisation from case studies has been raised, and Yin's response to this concern is that "case studies [...] are generalizable to theoretical proposition and not to populations or universes" (Yin, 1994, page 10). From case studies, researchers aim to generalise theories analytically, rather than statistically.

Current research also has geographical limitations in that the case study is conducted within two construction companies in Norway only. This means that results from this research may be valid only within the construction projects studied, or in companies in Norway that use the same approach to progression planning. Still, undertaking this in depth case study aimed not only to advance theory, but to address applied managerial concerns. As such, the case study may prove valid in the Norwegian construction industry as well as internationally. This view is supported by research on Last Planner

System implementation in many parts of the world (Jørgensen et al., 2004, Johansen and Porter, 2003, Auada et al., 1998, Alsehaimi et al., 2009, Conte, 1998, Skinnarland and Moen, 2010).

Besides a longitudinal case study a survey was conducted. The survey has its own limitations. The sample was not randomised and drawn from an exhaustive Norwegian population. The project sample (12) was selected on the basis of being defined as utilising collaborative planning methodologies, and the population within these projects counted all possible main contractor and subcontractor participants throughout the project duration. However, the sample was narrowed down to consist of those participants being present in the lunch facilities on one particular day. The 12 projects yielded a response rate of 485 respondents which filled the criterion of involvement in the progression planning methodologies. As the research question was concerned with experiences from this methodology, the lack of a strict randomised sample in this research was viewed not to raise particular concerns.

The assumed valid indicators addressed in section 1.5 have limitations in the nature of relationship between the indicators; in terms of cause and effects. It may be argued that efforts to affect levels of familiarity and common goal setting, involvement and communications, conflict, motivation, awareness of each other's perspectives and predictable working processes, by the use of progression planning methodologies, may result in improved collaboration. At the same time, it may be counter argued that by focusing on improving the separate indicators, this may result in improved progression planning. Although it can be argued that all explained relationships may be essentially circular, Aaltonen (2007) argues that a reflexive and self-critical approach needs to be adopted to understand our environments.

1.7 Chapter outline

The thesis is organised into six main chapters, following the introduction chapter. A review of the literature follows in chapter 2. The review provides an overview of relevant literature on collaborative culture, main contractor subcontractor relationship, and previous research on project management and the use of progression planning tools. Chapter 3 synthesises the review and pilot study results and arrives at the formal theory which was tested in this research. In chapter 4, all methodological considerations are outlined and chapter 5 presents the results of the data analysis. The results are then dis-

cussed and related to existing theory in chapter 6, prior to suggesting both main contributions to theory and practice, together with pointing to further need for research in chapter 7. Following chapter 7 are references and appendices.

Chapter 2 Literature review

2.1 Introduction to literature review

This DBA project was titled "Use of Progression Planning Tools in Developing Collaborative Main Contractor – Subcontractor Relationships in Norway". Empirically, the project was based in the construction industry and aimed to explore the nature of the main contractor subcontractor relationship in the construction project. The literature review addressed the challenges faced by this industry, with managing fragmented operations in temporary project settings.

This literature review centres on three main areas that, individually, offer a perspective on the DBA project as suggested by the title above. Firstly, in chapter 2.2, the terms culture and collaboration are explored in a historic and evolutionary sense, initially broadly, followed by a critical review of how the construction management literature have dealt with the topic. Secondly, in chapter 2.3, the review centres on the relationship between the main contractor and subcontractors, and addresses the nature, and challenges of managing such a relationship to improve collaboration. Thirdly, the scope of the project management role and progression planning tools are outlined in chapter 2.4. Chapter 3 synthesises the literature review.

2.2 Culture within nations, organisations and projects

2.2.1 Introduction

The purpose of this chapter is to provide an overview of the concepts of culture and collaboration. This doctoral research was narrowed down to concern collaborative development in the main contractor subcontractor relationship. Still, addressing culture per se, and the meaning of culture at higher levels, such as at organisational and national levels, may aid the understanding of how to analyse relational aspects within temporary settings like construction projects. In this chapter a brief history along with definitions

of culture and collaboration are offered, followed by an overview of the concepts related to organisations, projects, and lastly, to construction projects specifically.

The concepts of collaboration and culture have been defined and described extensively in the social sciences literature. Over the last 50 years various definitions and scope of the term culture have evolved. Barthorpe et al. (2000) provide an overview of some of the definitions attached to culture such as the association with cultivation of soil and plants, and high culture ("refinement of mind, tastes, and manners") (Barthorpe et al., 2000, page 336). Further, culture as an artistic expression, and as describing "the very fabric of society" (Barthorpe et al., 2000, page 335), as influenced by the academic fields of sociology and cultural anthropology. The nineteenth century British anthropologist, Edward Tylor, proposed a definition of culture "as socially-patterned human thought and behaviour" (As cited in Barthorpe et al., 2000, page 336). Kroeber and Kluckhom (1952) wrote a book after studying the history, definitions, and properties of culture and offered a list of 160 definitions of culture, later arranged and simplified by Bodley (1994) and Waterbury (1993). Bodley (1994) stated that culture is learned, and involves what people think, what they do, and their production of material products. Put simply, "culture is what we are and what we do as a society" (Barthorpe et al., 2000, page 338). Culture is shared among humans and refer to how people or groups of people in societies live their lives (Giddens, 1989, Haralambos et al., 1991), including people's ideas and beliefs, norms and language (Ellis and Lipetz, 1979), in a non-material type of culture, as opposed to material culture, where the objects are produced and used by a society.

Geert Hofstede (2010), in his third edition of *Cultures and Organizations*, explains culture in terms of software of the mind, which is also the subtitle of his book. Our mental software contains basic values. As individuals, we think, feel and act according to our mental programming. Hofstede describes the three-level uniqueness of human mental programming as consisting of *human nature, culture and personality*. Human nature is our ability to, for example, feel sadness, anger and happiness. These abilities are common among all humans, independent of, e.g., geography. They are inherited and not learned. The basic values contained in our mental software are manifested in conscious and more superficial use of rituals, heroes and symbols (Hofstede et al., 2010). These underlying values are unlikely to change (Child and Faulkner, 1998). The next level of uniqueness is expressions of feelings. These are modified by a learned culture from early childhood. The highest level of uniqueness is one's personality,

which is specific to each and every individual, and is not shared with any other human beings.

2.2.2 Organisational culture

Hofstede (2010) is one of several important authors in the field of organisational culture. He has included industrial and national contexts to organisational culture. National culture is manifested in symbols, heroes, rituals (practices) and values, as is organisational culture (Hofstede et al., 2010). According to Hofstede, symbols are the meanings of words, gestures, pictures etc. that a given culture shares. Young (1989) disputes this view and holds that organisational culture is the tensions between fragmentation and unity within an organisation, whereas symbols and myths are explicit manifestation of it. Heroes are certain characteristics important to a culture (Hofstede et al., 2010). They can be alive or dead, or even fictitious characters (Sinbad the Sailor or super hero characters like Superman and Spiderman). Rituals are collective patterns of acts such as the way we greet each other, and social and religious ceremonies. Values, on the other hand, are not practices, but rather our tendencies to "prefer certain states of affairs over others" (Hofstede et al., 2010, page 9). Values, according to Hofstede (2010), are learned from early childhood and may remain unconscious and difficult to observe directly by outsiders. Values have positive or negative feelings attached to them, e.g., evil vs. good or ugly vs. beautiful. Culture is shared and it is learned, not inherited (Haralambos et al., 1991, Hofstede et al., 2010).

Organisational culture is reflected in the unwritten rules of behaviour, of specific ways of acting and interacting within the organisation (Thompson, 1993, Hofstede et al., 2010), and thus reflect the underlying assumptions about proper behaviours and actions (Atkinson, 1990). Peters and Waterman introduced culture into the management literature in their book, *In search of excellence* (1982). The authors identified characteristics of successful organisations in the USA as being action-oriented, staying close to customers, encouraging autonomy and entrepreneurship among its workforce, generating productivity through people at all levels, being value-driven, emphasising core competencies, simple organisations with lean staff, and simultaneously centralised and decentralised. Peters and Waterman's work was later criticised (Thompson, 1993) on the basis that many of the firms subsequent to the 1982 publication became less successful. In the 2004 edition of their international best-selling book, Peters and Waterman answer to this critique by highlighting the point of the book, which was to learn from the companies who have had a long time success in the same way we learn from

top athletes in their prime. Organisational culture became prominent in the 1980s with an extensive literature on the topic of both organisational culture (Schein, 1984, Weick, 1987, Allaire and Firsirotu, 1984, Wilkins and Ouchi, 1983, Hofstede et al., 2010) and corporate culture (Schwartz and Davis, 1981, Kilmann et al., 1985, Sathe, 1983).

There exist many definitions of organisational culture, yet no standard definition is offered. In Hofstede's (2010) view, however, the many definitions offered by the extensive literature in this field share the characteristics of being holistic and historically determined. Building on the definition of culture as "the collective programming of the mind, which distinguishes the members of one group or category of people from another" (2010, page 6), Hofstede offers a definition of organisational culture as "the collective programming of the mind which distinguishes the members of one organisation from another" (2010, page 520). More recently, authors have challenged this view by adding further complexity to the understanding of organisational culture. Auch and Smyth (2010) found that there are different cultures even within the same organisation. Moreover, they found that within an organisation that operates in two different geographical regions, the regional differences in culture may influence the organisation more than the organisational culture.

In the period from 1985 to 1987, Geert Hofstede carried out a large research project (IRIC) on organisational culture using both qualitative and quantitative methods. Hofstede studied many different organisations within one and the same country (both in Denmark and in the Netherlands), looking for organisational differences. The IRIC study showed that organisational culture and national culture differed in nature (Hofstede et al., 2010). The roles played by value versus the roles played by practices in organisations were reversed with respect to the national level. Organisations showed considerable differences in their practices but smaller differences in their values, whereas on the national level, differences in values were more profound. Organisational cultures were mainly composed of practices, containing only a modest value component. Hofstede (2010) explains the difference by the socialisation at the workplace in adulthood, where organisational practices are learned. Based on the IRIC research, Hofstede (2010) developed a six-dimensional model of organisational cultures, which he defined as perceived common practices of symbols, heroes and rituals.

1. Process oriented vs. Results oriented (means or goals)
2. Employee oriented vs. Job oriented (concern for people or completing the job)
3. Parochial vs. Professional (organisational identity or job identity)

4. Open system vs. Closed system (welcoming or secretive)
5. Loose control vs. Tight control (approximately or punctually)
6. Normative vs. Pragmatic (market driven or organisational procedures)

The model is not prescriptive, as the positions on the dimensions cannot be given a qualitative character of being good or bad. Thus, based on his research, Hofstede (2010) refuted Peters and Waterman's suggestion that there is a one-best-way towards excellence.

An issue that has been raised is whether culture is something an organisation *has* or *is*. This is interesting in light of the current research that assumes that the collaborative culture in the main contractor subcontractor relationship is manageable through the use of collaborative progression planning tools. Hofstede (2010) defines a strong culture as a homogeneous culture in which employees express more or less the same traits or characteristics of the organisation. Korzilius (1998) stresses the need for a unified and strong culture for projects to be successful, and Walker (2007) goes on to state that the advantage of a strong culture in construction projects is enhanced effectiveness.

Based on the IRIC research project, culture is something an organisation has (Hofstede et al., 2010) as opposed to is (Smircich, 1983). When project culture is analysed as something an organisation has, practises of the organisations are manageable. Further, the practices become dependent on the structures and systems of the organisations. On the other hand, organisational cultures are also integrated wholes, thus representing something an organisation is. However, within the wholes, Hofstede argues, there is a freedom to influence the practices. Influencing the practices, and the change following the altered practices, can be managed by implementing changes to the structure, processes or personnel management.

Before moving on to look at culture in terms of the project level in the construction industry, the following description and characteristics of this industry may inform the reader about the setting within which to understand project culture in construction.

Ballard and Howell (1998) describe the peculiarities of production at the construction site. According to Koskela (2000), production in construction has a set of unique characteristics. The products are one-of-a-kind products based on unique customer requirements. As such, it resembles, e.g. that of shipbuilding production, and production of major control systems and high end computers. Construction entails site-production, the movement of resources ("men and material") around a product that is fixed in one place. Since the product is rooted in one place the customer is highly integrated in the

production. Further, the production is characterised by a temporary composition of interdependent firms, which Eccles (1981) refers to as quasi firms.

Many authors have addressed the peculiarities of the construction industry (Harvey and Ashworth, 1993, Vrijhoef and Koskela, 2005, Ballard and Howell, 1998). Descriptions of the industry flourish: it is fragmented (Porter, 1980); there is no market leader (Male and Stocks, 1991); Gale (1992) holds that the construction industry is male dominated, resulting in a macho behaviour. Inviting more females into construction would benefit the industry (Langford et al., 1995), as would the adoption of a 'soft' human resource management approach (Dainty et al., 1998). The Latham-report *Constructing the team*, contends that the construction industry further suffers from deep-rooted confrontational attitudes, and a breakdown of trust and openness (Latham, 1994). The industry has a reputation for being difficult, demanding, containing an adversarial culture (Harvey and Ashworth, 1993), and for being dirty, dangerous, and having low status (Latham, 1994). The levels of innovation are reportedly low compared to other industries (Barthorpe et al., 2000), although this view is challenged by Winch (2003) who finds that comparisons between industries may be flawed. In the UK, the last fifty years of problems within the construction industry has been widely commented on and debated (Johansen et al., 2004). Innovation efforts have been proposed. Based on many years of publications in the field of construction management, Johansen and his colleagues (2004) suggest that the problems involving a lack of collaboration within the British construction industry are recurrent and institutional. Despite a great pressure to change, the industry response is slow. The general British perception, (www.constructingexcellence.org.uk/) is that there are two kinds of cultural barriers to successful construction projects. First, the problems are profound and historically rooted, and related to power imbalance, multiple loyalty considerations, differing interests and a lack of a will to commit. Second, fragmentation and temporary production settings create mistrust and uncertainty.

2.2.3 Construction Project and collaboration

In their literature review on project culture, Zuo and Zillante (2005) conclude that there is no clear definition of project culture, especially in the contexts of construction projects. Based on well-recognised definitions of organisational culture (e.g. Hofstede, 2001, Schein, 1985), Zuo and Zillante (2005, page 357) propose a definition of project culture as: "the shared values, basic assumptions and beliefs that the participants involved in a project hold that determine the way they process the project and the rela-

tionship with each other in the project environment". Following this definition it is clear that people and relationships are fundamental in understanding project culture in construction.

Culture is not tangible, but exists between people (Alvesson, 2002) and therefore cannot be studied independently of context. Hancock's (2000) cultural characteristics of the construction industry, as a conflict culture, fragmented culture, a culture of labour mobility, contractual culture, crisis management culture and a masculine culture, are all examples that show that the concept of culture in relation to construction projects is difficult to grasp. To complicate project culture further, there is an asserted need to take into account the dynamisms of temporary multi-organisations, TMO's (Fellows, 2003). Culture is manifested through the way people behave in organisations, where they come together more or less temporarily to pursue purposes (Fellows, 2003). The individuals, particularly those working in TMOs, like the construction industry, experience constant change to varying degrees (Fellows, 2003). Changes are related to new designs, trades that enter and exit the project at different times, and shifting rules and regulations from construction authorities.

Even though the starting point for an investigation into collaborative relationships in construction projects has been broad, starting with project culture per se, this research limited the scope down to collaborative relationships in construction projects.

Webster's online Dictionary states: "Collaboration means to work jointly with others or together especially in intellectual endeavours." "Collaboration remains a somewhat elusive concept and few guidelines exist for how to ascertain whether and when it has occurred and to what degree it has been successful" (Gray, 2000, on page 244). The essence of the definitions of collaboration offered, though, is that two or more people work together effectively (e.g. Hofstede, 2001).

There seems to be limited definitions of the term collaborative culture. Zuo and Zillante (2005) find no definition of collaborative culture related to the construction industry. This view is strengthened by Reagle (2008), who holds that the cultural development and meaning of the collaborative culture remains largely unexplored. However, Montiel-Overall (2005, page 32) offers a definition of collaboration as a "trusting, working relationship between two or more equal participants involved in shared thinking, shared planning and shared creation". Reagle (2008) goes on to define collaboration as an interactive activity of shared purpose. A shared purpose emerges from a common understanding between participants and is often made manifest in a result for which a whole is greater than its sum parts; to collaborate is to 'co-labour,' or work to-

gether, towards a common end. This is not required by the terms cooperation and coordination (Reagle, 2008).

2.2.4 Attempts at understanding collaboration

As pointed out by Egan (1998), the construction industry needs to move towards a more collaborative culture, and the acknowledgement of the peculiarities of this industry as described by Ballard and Howell (1998) is a starting point to develop knowledge about how to create a collaborative culture.

Several attempts have been made to approach the challenges faced by this industry. Given the aforementioned characteristics of the construction industry, the importance of collaboration and cooperation of all actors involved in the construction project is given high priority in this research. Partnering and supply chain management (Egan, 1998) as well as Lean Construction (Koskela, 1992) are concepts that have been suggested as promising means to improve the coordination and integration between actors and processes in construction, and in turn, enhance productivity performance (Court, 2009). These concepts will be addressed in due course.

Supply chain management

Increasingly, scholars have emphasised the analysis of construction projects in terms of project (or temporary) supply chains, replacing the more traditional concern for improving each trade independently (Andersen et al., 2008). Bowersox et al. (1999) define supply chains as networks of actors that transform raw material into distributed products, and thus coordination of the supply chain is essential. This definition fits well with the construction industry where deliveries are integrated in the making of the product, whether it is a large building, a bridge or a private home (Andersen et al., 2008). The purpose of Supply Chain Management (SCM) is actor integration through effective and efficient relationships (Bygballe et al., 2010). The "network form of governance is most appropriate in conditions where partners provide specific assets, and [...] where complex tasks have to be undertaken under conditions of considerable time pressures" (Segal-Horn and Faulkner, 2010, page 200).

Supply chain management, the management of a network of organisations in carrying out operations (Harland, 1996), originated in physical distribution and transport. In construction, Briscoe et al. (2001, page 245) contend that "the main trade contractors will have their own supply chains and many of these will further subcontract out smaller work packages. The specialist construction subcontractors will usually be much smaller firms, small to medium size enterprises, SMEs, and several of these may be providing

labour-only services. The composition of the network will tend to be unique to a specific contract, although some favoured suppliers will be used repeatedly by any given main contractor".

Given the lack of a strong culture in typical supply chains, Hult et al. (2006) argue that shared meanings of supply chain data and events are needed to harness collective action. By shared meaning Hult refers to a relationship where the stakeholders have similar goals and values for their relationship, or as interpreted by James et al. (1988) as a 'collective attitude'. A chain's members have other (perhaps conflicting) roles to fulfil outside of the chain. Members' loyalties may lie within their home organisations or adjoining members rather than within the chain (Hult et al., 2004). This may create ambiguity of identities that create tensions within the team (Alvesson, 2000). Supply chains in the construction industry, in phases of the project, may include numerous subcontractors who are expected to work towards completing the production of the construction product in question. It is an understatement to assert that these circumstances offer challenges to develop a shared meaning, or a shared destiny, as a sense of common purpose (Katzenbach et al., 1993).

Supply chain management (SCM), analyses the value chain with particular emphasis on the interdependencies in the entire chain (Vrijhoef and Koskela, 1999). Due to the high dependency between actors in the chain, the problems that arise in one place are often related to other parts of the value chain (Vrijhoef and Koskela, 1999). Indeed, the large quantity of waste and problems are often caused at previous stages in the supply chain, over which participants have no control, as they can only control each stage independently (Vrijhoef et al., 2001).

SCM originates from the Toyota supply system, used to coordinate and manage their supply (Womack et al., 1991). The main contractors in the construction industry are also increasingly dependent on other actors in the chain, such as suppliers and subcontractors. SCM thus can be a suitable tool for analysing relationships within the construction industry. Vrijhoef and Koskela (1999) suggest an increasing focus on SCM in construction, where the goal is to reduce costs and hours. The primary objective is to ensure that materials and people flow to the construction site in such a way that the workflow is not interrupted. Isatto and Formoso (2006), however, argue that SCM in the construction industry can be problematic since the industry is different from mass production, from where the SCM originated.

Supply chain as strategic resource

Scholars in strategic management have in general started to view supply chains as strategic. The use of supply chains are not merely seen as a means to get products where they need to be, but also as a tool to enhance key outcome (e.g. Hult et al., 2002, Hult et al., 2004). In line with the resource-based view (RBV), these authors emphasise in particular the importance of resources, such as labour, transportation and equipment (market inputs), facilities and tools (assets held by the firms) and, not the least, knowledge and capabilities (competences), in tying supply chains closer together and strengthening these ties.

Hult et al. (2004), state that strategic supply chains benefit when participants learn to think alike. A rigid interpretation of his statement dictates that the optimal outcome of managing a supply chain is a homogeneously thinking and acting group of participants. Nevertheless, what a project needs may be participants who, on the contrary, do not think alike, but rather bring individual perspectives, ideas and solutions to the table. It might, however, be necessary to focus more on developing a shared destiny among the actors in the project. A community of shared destiny may be founded on a sense of collective identity (Spear et al., 2001). The cohesiveness of a group may strengthen this sense of a collective identity. Cohesiveness within supply chains has attracted authors' interest, and an evolving feature of modern competition is that rivalry is becoming less 'firm vs. firm' and more 'supply chain vs. supply chain' (Hult and Ketchen, 2006).

In order to study collaborative culture, strategic management literature focuses on the management of supply chains as a strategic resource (Hult et al., 2004). Resources, inspired by the resource-based view, can be used to implement value-creating strategies (Barney, 1991, Wernerfelt, 1984, Wernerfelt, 1995). The fundamental principle of the resource-based (RBV) view is that the basis for a competitive advantage of a firm lies primarily in the application of the bundle of valuable resources at the firm's disposal (Wernerfelt, 1984, Rumelt, 1984).

Network of actors

"[…] a supply chain is composed of a network of interdependent relationships developed and fostered through strategic collaboration with the goal of deriving mutual benefits" (Chen and Paulraj, 2004, page 147). In line with Hult and Ketchen's view on the supply chain versus supply chain as an analysis for modern competition, Dyer and Nobeoka (2000) propose that if a network can establish rules for coordination, it will surpass the single firm as an organisational form; it will be more capable of creating and

recombining knowledge with the diversity of knowledge that networks accommodate. In the construction industry, this implies that the scope of analysis must include interdependent collaboration and cooperation among the project participants.

"Most behaviour is closely embedded in networks of interpersonal relations", and the social structure is the "key to understanding how existing institutions arrived at their present state" (Granovetter, 1985, pages 504 and 505). What appears to be irrational behaviour may be rational in given situations.

Relational approach/view

Several authors argue that in order to develop resources and create competitive advantage, companies must consider the benefits of inter-firm collaboration (Løwendahl and Revang, 1998). Collaborating firms can generate relational rents through relation-specific assets, knowledge-sharing routines, complementary resource endowments, and 'effective governance' (Dyer and Singh, 1998). The relational view offers a useful theoretical lens through which researchers can examine and explore value-creating linkages between organisations (Dyer and Singh, 1998). Cox and Thompson (1997) refer to a growing interest among UK construction actors in developing collaborative relationships. They state that partnering, as one example of a relational approach, has gained popularity. Similar findings are reported by Baden-Helland (1995) and Cox (1996). The investigation of more collaborative contractual relations and supply chain management is common in the construction industry (Cox and Thompson, 1997). Attempts to explain the adversarial culture in the construction industry have partially been inspired by the strategic management literature with a focus on a relational approach (Rahman and Kumaraswamy, 2002). Relationships between firms have become an increasingly important unit of analysis for explaining above normal profit returns. The relational view is grounded in the perspective of strategic management theory that emphasises the development of collaborative advantage (e.g. Kanter, 1994, Dyer and Singh, 1998, Dyer and Nobeoka, 2000), as opposed to competitive advantage.

IMP

In line with the relational approach, IMP (Industrial and Marketing and Purchasing Group) scholars further argue that firms can be analysed from a network perspective (Huemer, 1994), and a major point in network thinking (Gadde and Håkansson, 2001) is that at least some of the 'others' need to be included. IMP-researchers argue that the interconnectedness is underestimated and that managers try to manage relationships in

isolation (Ritter, 2000). According to IMP researchers, the aim of strategic actions is to influence the way actors perceive the connections between their relationships. This view is an important element in this research which assumes that, developing a relationship where the participants to a larger extent come to view the others' perspectives, not only their own, will be crucial to turning from an adversarial towards a collaborative culture.

Inter-organisational projects (IO)

Projects can be viewed in terms of a business strategy that has been increasingly used to coordinate contributions from multiple organisational actors. Inter-organisational projects, (IO) (Jones and Lichtenstein, 2008) involve two or more organisational actors from distinct organisations working jointly to create a tangible product or service within a limited period of time. Interdependence and collaboration are central to IO projects.

The participants' interactions are shaped and modified by the limitation in the time span of a project. Projects are by definition temporary in contrast to, e.g., joint ventures and alliances, that more commonly lack a defined end date. Inter-organisations are used to coordinate the production of complex products or services in uncertain and competitive environments (Jones and Lichtenstein, 2008, Eccles, 1981). In dealing with this uncertainty, partners in IOs develop knowledge about each other's preferences and procedures through repeated interaction (Eccles, 1981) and coordinate their interactions to manage the uncertainty.

Jones and Lichtenstein (2008) argue that a deeper understanding of inter-organisational collaboration and networks can be gained by examining the project itself as a unit of analysis. They analyse project collaboration in terms of inter-organisational projects using temporal and social embeddedness as analytical dimensions. "Embeddedness advances our understanding of key economic and social outcomes" (Uzzi, 1997, page 48). *Temporal* embeddedness is defined by the project period and what kind of pacing mechanisms may be effective for coordinating the activities, such as *chronological pacing* (deadlines, contracts and timelines), *event-based pacing* (coordination using milestones and phases), or *entrainment pacing* (synchronising of collaborative activities) (Jones and Lichtenstein, 2008).

Social embeddedness refers to the frequency, duration and pattern of relations (Granovetter, 1985) and addresses the project participants' shared understandings about the pace, processes and how they interact and coordinate the activities within the project. This shared understanding clarifies knowledge content, roles, and the duties spe-

cific to these roles, and the various role behaviours expected for optimal coordination. On the basis of Jones and Lichtenstein's view of how shared understanding is embedded in the industry culture, a point may be raised about why the construction industry experiences not just a lack of trust, but even distrust between the collaborating actors. One reason for this may be found in the lack of common goals in construction projects, compared to, e.g., film industry projects. Jones and Lichtenstein (2008) discuss the importance of temporal and social embeddedness in achieving project goals. In the film industry, participants may to a larger extent be guided by one common goal of producing the best possible film within time and budget constraints. That is, when participating in making a film, participants' input is measured in the total output, the film. This may or may not be the case in construction; on the contrary, this industry has shown that a multitude of a disparate set of goals exists.

2.2.5 Summary

This chapter has provided an overview of the concepts of culture and collaboration. A vast amount of definitions of organisational culture exists, although they seem to share some characteristics of being holistic and historically determined (Hofstede et al., 2010). Although this doctoral research centres on the relationship between main contractors and subcontractors, an overview has been given of the meaning of culture and collaboration on a national and organisational level as well as on a project level. Previous research on organisational culture in particular has informed this research and deepened the understanding of the nature of collaborative culture within projects in general and in construction projects in particular.

Many researchers have contributed to describing the characteristics of the construction industry and its peculiarities. Many of these characteristics share a negative undertone. There seems to be a growing urgency among authors to address the adversarial relationships in this industry, and in particular, to point to the need to improve collaboration (Egan, 1998).

Many attempts have been made at understanding collaboration within and between firms. In this review, some of these perspectives have been introduced. A common thread among the different perspectives seems to be the emphasis on interdependence, and the pooling of resources between the actors in the projects. This was useful knowledge to draw on in the exploration of the main contractor subcontractor relationship.

The next chapter will add to the knowledge of relationships in project settings by a focused attention on the relationship in one area of the construction supply chain; the relationship between the main contractor and subcontractors.

2.3 The relationship between the main contractor and subcontractor

2.3.1 Introduction

In chapter 2.2, culture and collaboration were explored in broad terms. Building on knowledge from the national and organisational levels, the scope was narrowed down to address project culture and collaboration. In this chapter the scope is even narrower. Instead of treating collaborative culture on the project level, which would involve an extended supply chain comprising, e.g. planning and design in addition to the project operations phase, the particular interest in this chapter is the relationship between the main contractor and subcontractors.

The fundamental assumption for a collaborative effort in construction to succeed is that there may be certain barriers to collaboration that need to be managed. This chapter addresses the relationship between main contractors and subcontractors as presented in the literature. The literature review on the relationship between the main contractor and subcontractor takes as a point of departure the characteristics, mentioned in chapter 2.2, of the construction industry as being adversarial, fragmented and ridden with conflicts. Although Bygballe et al. (2010) concluded that little attention has been paid to the role of subcontractors and suppliers or the multi-actor nature of construction; partnering efforts have increased as a means to overcome suboptimal relationships, as have the formation of alliances.

A special interest is taken in how partnerships and alliances are created and particularly which barriers to such collaboration exist. Subcontractor selection processes may shed light on the nature of the relationship, as may use of contracts. Barriers to collaboration are also addressed, such as the use of piece rate work. Lending from game theory, collaborative behaviour in situations of strategic importance is explored. The topic of trust has been approached in terms of how trust can be built, and help in developing collaboration. Last in this chapter, a discussion follows concerning indicators of collaboration.

Many books have been written about the relationship between the main contractor and their subcontractors. Some of these books concern the bidding processes; how to

handle contractual relationships and disagreements; and construction law and management. This review emphasises how the relationship evolves within the project.

This review builds on Zuo and Zillantes' definition of project culture as "the shared values, basic assumptions and beliefs that the participants involved in a project hold that determine the way they process the project and the relationship with each other in the project environment" (Zuo and Zillante, 2005, page 357). Within the limits of this definition, the manner in which contractors may manage to create and develop a collaborative culture based on shared values, basic assumptions and beliefs, is addressed.

2.3.2 Relationship barriers and opportunities

The need for closer and less formal relationships within this industry is widely accepted (Jørgensen et al., 2004). Dominant subcultures within trades and professions create a barrier to adopting a process-oriented form of collaboration. The authors refer to a large Danish project that illustrates the difference between participant's intentions, norms and culture. Culture is important to our interpretation and understanding of production and social processes. The introduction of Lean Construction principles constitutes more than a revision of current procedures; it is concerned with interpreting the current cultures (Jørgensen et al., 2004).

The Danish study by Jørgensen and his colleagues, shows that Lean Construction as a concept was perceived differently by the subcontractors and the main contractor. The researchers found that the different cultural interpretations, and opinions about the construction process, became an obstacle to a process-oriented collaboration. An example from the study that demonstrates this was the subcontractors' expressed fears, that minutes from planning meetings would give the main contractor a means of control, and could be used against them in later meetings and discussions. Participants in the Danish project were reluctant to share information and to plan ahead. According to Jørgensen (2004), planning meetings were perceived to be an arena for discussions about whom to blame when deviations from the plan occurred.

The scepticism towards the main contractors' intentions and the feared consequences of any deviations from plans as reported by Jørgensen et al. (2004), are only one of several barriers to collaboration referred to in the literature.

As pointed out in several reports, e.g. by Egan (1998), the construction industry needs to establish closer relationships and enhance collaboration if some of the less optimal conditions related to this industry are to be rectified. In the UK, there have been

reports on attempts at partnering (Cox and Thompson, 1997), commonly initiated by large construction companies.

Briscoe and his colleagues (2001) explored the skills necessary to operate partnership relationships. Based on a survey and in-depth interviews with small and medium sized enterprise (SME) senior executives, more than 20 skills were identified as potentially important to efficiently operate supply chain partnerships. The skills perceived to be most important were those associated with reading and understanding technical documentation and legal contracts. The study also revealed several barriers to the partnering processes, mainly in the form of a lack of trust, based in fears of being taken advantage of in partnering agreements, an unwillingness to share information and knowledge, and attitudinal barriers in line with findings from the Danish study.

Dainty et al. (2001b) studied the role of small and medium sized construction companies (SMEs) and the possible barriers to partnering agreements between main contractors and SME subcontractors. From their interviews with key personnel at strategic and operational levels they found barriers both in the main contractor and subcontractor companies. There was a misalignment between the strategic level and the staff that implemented the projects in terms of the use of price as the single method for selecting partners. At the operational level, besides cost issues, it was emphasised that company added value needed to be identified and taken into consideration.

From the subcontractor perspective several groups of barriers were identified (Dainty et al., 2001a). These were issues related to financial/cost, programming/time, quality of information and attitude. Competitive tendering with acceptance of lowest price was reportedly contradictory to effective integration. Even the tendering process itself caused adversarial relationships to develop. In the partnership, problems with payments, late or withheld, led some SME companies into cash flow difficulties. A consequence of such behaviour may be game playing (Sacks and Harel, 2006) to protect against financial risk. Issues related to programming and time administration concerned the lack of alignment of subcontractor and main contractor systems and time schedules. Information sharing is crucial in any collaborative attempt. Dainty and his colleagues (2001a) found that lack of information, wrong information, or information received too late, greatly impacted subcontractors work. They also noted a felt reluctance to utilise subcontractor expertise in problem solving. This signals to the subcontractors an imbalance in the relationship in terms of knowledge, competence and status. The attitudinal issues revolved around arrogance, aggressive acting, and exclusion, lack of understanding, and lack of praise and hindrance of knowledge sharing on the part of the main con-

tractor. The lack of trust, based on years with adversarial relationships, is a fundamental barrier to improved relationships. Dainty and his colleagues (2001a, page 846) note that there is currently a belief that "existing supply chain management processes seek to enhance main contractor profitability at the expense of other supply chain companies".

2.3.3 Formation of alliances, selection of subcontractors

A leading firm allows for coordination of activities of partnering firms (Jones and Lichtenstein, 2008). The selection of subcontractors is traditionally based on a company's individual competence and less on the ability to integrate and work together effectively (Baiden et al., 2006). Attempts at bringing together the project participants and utilise the combined strengths, may yield success in terms of project delivery (Howell, 1996).

In the construction industry, companies operate in their traditional organisational form of an interfirm network, and as such, subcontracting uses mechanisms that are distinct from some other industries (Eccles, 1981). Eccles uses the term quasi firms to describe the interfirm coordination characterised by organic and informal systems in contrast to bureaucratic structures based on a formal contractual relationship. Uncertainty surrounding transactions is a key element to understanding the contract schemes adopted in the construction industry. Selection of partners is rarely through purely formal rules. Bidding, for example, is used mostly to "test the market" (Eccles, 1981).

Use of contracts

Production is to a greater extent than earlier carried out with the use of subcontracts, and Shimizu and Cardoso (2002) use the term 'cooperation network' as a framework for analysis of this type of production. Cooperation network results from strategic alliances between participants in the value chain. (Value chains and supply chains are assigned similar meanings in this review and are used interchangeably). Companies cooperate to achieve better results than they would individually.

There is a high degree of competitive bidding for subcontracts in construction and the use of contracts to govern business relationships has increased since the post industrial revolution (Fellows, 2003). Most contracts are prepared and written by the owner without negotiation (Zaghloul and Hartman, 2003) and demonstrate low levels of trust in contracts between owner and contractor (Zaghloul and Hartman, 2003). There is an increase in subcontracting at the expense of direct labour (Greed, 1997). Greed (1997, page 15) asserts that "the whole industry seems to work by each level putting pressure on the next one down".

The amount of subcontracting is positively related to project complexity and size (Eccles, 1981). Eccles explains this relationship with the general contractor's bounded rationality in highly uncertain conditions. In stable and continuous relationships between main contractors and subcontractors a 'quasi-integration' takes place. Eccles argues that in quasi firms both parties benefit when such a relationship develops. Quasi firm contracts as an organisation of economic activity are located between pure markets and vertically integrated hierarchies (Williamson, 1975).

Although on-off contracts between main contractors and the supply chain are most common, and long-term relationships are still limited (Briscoe et al., 2001), relational contracting is the basis for an alternative governance form between markets and hierarchies (Eccles, 1981). Eccles wrote a pioneering paper on interfirm contracts in which he analysed the relationships between general contractors and their subcontractors. When investigating 38 homebuilders, Eccles found that more than 80% of the subcontractors were selected through negotiations, while the remaining 20% were selected via formal competitive bidding.

A common organisation of a project is a general contract with total responsibility for the project within fixed prices and deadlines, with financial incentives and penalties attached to them (Eccles, 1981). General contracts are often selected by competitive bidding. Other forms of contracts are, e.g., cost plus contracts. Design and build contracts bring together the design and construction phases of projects (Stutz, 2000).

Contracts also provide normative guidelines for cooperative behaviour (Gulati, 1995). There is a growing tendency among leading British contractors, however, to enter into partnering agreements (Briscoe et al., 2001).

Slivon et al. (2010, page 9) hold that "[t]raditional forms of contract in the construction industry attempt to minimise risk by one party at the expense of another". They refer to Integrated Form of Agreement (IFOA) as an "innovation which enables participants to work together to minimise total risk and to share the remaining risk equitably from the beginning to the end" (Slivon et al., 2010, page 9).

Use of piece rate work

Traditional pricing methods, such as unit price and lump sum, have been criticised for their contribution to the adversarial culture in the construction industry (Kaka et al., 2008). Several authors recommend a shift from practices of non-productive, adversarial and conflict ridden payment practices to the adoption of other emerging payment methods. These are payment methods that acknowledge the close relationship between the

pricing system and the project objectives, and thus promote and support integration and collaboration (Kaka, 2001, Egan, 2002). Other empirical studies suggest that pricing systems, such as the unit piece system, may enhance collaboration by putting pressure on the project management to facilitate activities to be performed according to plan. Most importantly, however, is how the pricing system is used in the project to involve all workers and managers to focus on progression, and not the tool itself (Skinnarland and Andersen, 2008).

2.3.4 Game theory

There has been a growing academic interest in cooperative behaviour (Ring and Van de Ven, 1992, Browning et al., 1995) and, in particular, in vertical cooperative relationships between firms in business markets (Eccles, 1981). Gulati (1995) examines the factors that explain the choices of governance structure in individual alliances. He contends that opportunistic behaviour generates the main transaction costs in alliances, and contracts thus become a means to protect against such possible behaviour (Gulati, 1995), contracts, which thus reflect the partners' rated risk (Ring and Van de Ven, 1992).

Sacks and Harel (2006) refer to game theory when they explain the relationship between the main contractor and subcontractors. The two parties make their moves depending on the other party's moves. Parties respond, in other words, to the actions of the other, and this *act-react* interaction develops the relationship over time. Harel and Sacks (2006) refer to a survey where they explored the degree of reliability among project managers and subcontractors in terms of demanding and allocating resources. Nearly half (48,3 percent) of the project managers claimed they would exaggerate work demanded by at least 20 percent. Likewise, more than 85 percent of the subcontractors believed that less than 80 percent of the work would in fact be ready for execution. Sacks and Harel (2006) suggest that the Last Planner System encourages more collaboration and stability and thus dampens a possible negative act-react interaction loop.

Two reasons for initially seeking to establish cooperation are found in the need to pool resources and the need to respond to threats (Axelrod, 1984). Axelrod, who is a leading authority on game theory, presented an insightful study of cooperative game playing, where he explored how cooperation can emerge in a world of egocentric individuals and businesses. He presented a cooperation theory, which was initially based on investigation into individuals acting upon their self-interest with no one forcing them to cooperate. His experiments were based on games like the TIT FOR TAT and the Pris-

oner's Dilemma (Axelrod, 1987), and Axelrod argued that if the theoretical facts are known to the participants, this will aid speeding up the cooperation.

2.3.5 Trust in the main contractor subcontractor relationship

The issue of trust is at an all-time high (Kerzner, 2010). Kerzner holds that partnership contracts are now based on the faith in the ability to deliver successful projects.

Trust is embedded in the collective experience of an industry (Jones and Lichtenstein, 2008). In the case of the construction industry, this assertion may be modified. The construction industry has been criticised for the lack of trust and high levels of conflicts. Jones and Lichtenstein may thus be counter argued; that it is distrust rather than trust that is embedded in the construction industry.

The role of trust in construction projects has been emphasised by many authors (e.g. Huemer, 1994, Sheth and Parvatiyar, 1995, Dominic et al., 2013). Trust is a social process which is created and reproduced through time (Uzzi, 1997). Construction projects are faced with high risk, uncertainty and interdependence between the various trades. In such commercial relationships, trust is a key determining factor to success (McKnight and Chervany, 2001).

Trust is a central mechanism of the collaboration among construction project partners. On the other hand, distrust increases transaction and collaboration costs, and leads to the failure of the collaboration (McKnight and Chervany, 2001). Key success elements for enhanced collaboration are communication, motivation and trust-building (Huemer, 1994). Vrijhoef et al. (2001) hold that 'small wins', in terms of promises kept, motivate firm commitment and build trust (for more on this, see, e.g., Solomon and Flores, 2001). This is in line with Granovetter (1985) who holds that a continuing relationship between individuals motivates trustworthiness, and Slivon et al. (2010, page 10), who note that "trust can grow out of the repeated, reliable fulfilment of promises". Uzzi (1997) contends that trust develops when individuals voluntarily make extra efforts and reciprocate such behaviour. As such, trust "permits actors to be responsive to stimuli" (Uzzi, 1997, page 44).

Kumaraswamy et al. (2008) note that the incorporation of partnering type agreements into many projects has contributed to a change in culture and can lead to more open attitudes with respect to cooperation and collaboration in construction projects. Uzzi (1997, page 43) found that trust promoted organisational invaluable assets, especially "when firms cooperatively traded resources that produced integrative agreements".

Trust itself can be difficult to observe and measure. Companies act based upon the level of trust experienced with another partner, and Gulati (1995) finds that companies that have done repeated business together in the form of an alliance, are less likely to use equity as a basis for forming an alliance. In other words, companies select contractual forms for their alliances on the basis of the activities they include, and on the existence and reoccurrence of a partnering relationship (Gulati, 1995). This is in line with Eccles (1981), who finds that companies in the U.S. construction industry have repeated business with each other, based on trust rather than on legally binding contracts. Careful contracting, taking into account also social factors, such as trust, gives way to less formal practices as partner companies build confidence in each other (Gulati, 1995). Thinking in terms of measures, then, less formal partnering practices may at least point in a positive direction on the trust indicator.

Prior interactions from repeated alliances may determine the choice of new alliance partners as well as economic elements (Ring and Van de Ven, 1992). One example is loyalty which has resulted from trust, built on previous inter-firm alliances. Organisations may develop close relationships through recurrent interactions (Sabel, 1993). Eccles (1981) holds that information sharing between organisations, and the development of personal relationships among key individuals, are crucial in producing trust between contractors. He also contends that partners that interact more often may foster learning of each other's systems. Familiarity between organisations through prior alliances breeds trust (Gulati, 1995, Bee and Bee, 1997) and develop understanding (Brown et al., 2010).

2.3.6 Cultural change, theory and managerial implications

Although the importance of building trust to develop close relationships is clear, it is also important to be aware that moving from a state of adversarial to a state of collaborative, trusting relationships, entails a deep, profound change in culture. This change in culture needs to be managed, and Meyerson and Martin (1987), in reviewing the works of others (Smircich, 1983, Weick, 1979, Schein, 1985) offer some interesting thoughts about cultural change and managerial implications. Meyerson and Martin described the managerial implications in terms of cultural change related to three perspectives. First, viewing organisational culture as a closed system, in which cultural change is initiated and controlled by top management. The second perspective view culture as a more open system where change has many sources, as responses to both external and internal

environment. The third perspective view change as continual and uncontrollable, and emphasise the individual adjustment as the main source of change.

Meyerson and Martin (1987) discuss the perspectives in terms of reaction to ambiguity, which in their research means "that which is unclear, inexplicable, and perhaps capable of two or more meanings" (borrowed from Webster, 1985). Meyerson and Martin (1987) suggest that any study of cultural change in organisations should combine all three perspectives simultaneously, to understand which that may be amenable to managerial control. This is interesting in light of the levels of ambiguity that needs to be managed within construction projects.

2.3.7 Principles of Organisational Development (OD)

The globalised world put pressure on organisations to continually develop and to adapt to demanding markets. This continual improvement requires that organisations change how they do their business, their processes and procedures, and ultimately how people and teams of people behave and interact (Garside, 1998).

Several detailed theoretical step-by-step models with diverse perspectives of organisational development are available for organisations that wish to develop and sustain their competitive advantage (Cacioppe and Edwards, 2005). Other types of theories explain the change processes in organisations in terms of sequences of change taking place at different organisational levels and with disparate drivers (Van de Ven and Poole, 1995).

Moland (2007) warns against the use of conceptual (tool or model) driven organisational development as many of the concepts are characterised by being fads which are not developed internally to meet the needs of the organisation, but rather are external to the organisation. Many concepts draw attention to solutions that the concept can offer, rather than the solutions the company may need, and thus resulting in a narrowing of the problem area (Falkum, 2000, Røvik, 1998).

Researchers point to key issues that need to be addressed in all organisational development. Dawson (2000) holds that OD development processes must address the organisational knowledge capabilities on a constant basis. Moore (1999) emphasises the need for diversity management with a universal or holistic approach to incorporate critical evaluations, and discusses the relationship between diversity and performance. Diversity is a multidimensional concept, according to Moore, which in its broadest sense impacts on all members of a particular organisational setting. He also highlights how organisational development processes may gain from support policies, networks, and the

use of mentors and role models. Cacioppe and Edwards (2005) call for greater integration, which is lacking in the construction process (Akintoye et al., 2000), and tolerance for complexity. Still other researchers highlight the need for strategic approaches to analysis, choice, change plan design and implementation (Cummings, 2005, Moland, 2007).

In construction, as in many other industries, Akintoye (2000) found that supply chain collaboration and management is critical for future success. A lack of trust has ridden this industry and Akintoye observes that only recently is trust being actively cultivated by the industry. Other barriers pointed out by Akintoye (2000) are lack of senior management commitment, appropriate support structures and a widespread ignorance of supply chain philosophy. He prescribes training and education to overcome these barriers. The principles of OD practices referred to above evidences the managerial challenges in changing practices in terms of construction progression planning. Collaborative planning activities may depend on meeting structures and organised planning levels, however, the elements mentioned above, e.g. knowledge and diversity management, integration and support may be vital elements to address when changing practices.

2.3.8 Process of developing a collaborative culture

Collaborative efforts are characterised by a successful start and constructive evolvement over time. Doz and Baburoglu (2001) refer to work by various researchers, mainly in the eighties and nineties, on the evolution of cooperation in alliance situations over time. Some of these were individual research case studies; others were larger-sample studies, and some took the form of evaluations of the value of the actual consequences of cooperation. Although the forms of cooperation varied, Doz and Baburoglu found some similarities in their generative processes, from which they developed a process model of cooperation. The alliances, in a similar vein, developed common ground, through formal structures, informal relationships and by "engaging in explicit mutual commitments" (Doz and Baburoglu, 2001, page 174).

Dainty et al. (2001b) suggest that an attitudinal change is required if SMEs are to be integrated in supply chains, and suggest educational approaches towards improved communication skills, supply chain knowledge and partnering benefits. It can be discussed whether an attitudinal change is something that can be expected or demanded of subcontractors, or if changes in attitude rather will follow from experienced changes in benefits from collaboration (Skinnarland and Yndesdal, 2010).

Slivon and her colleagues (2010) analyse people's activity from the point of view of human beings looking after their own interests. They explore how people's collectively purposeful actions may be coordinated through the use of language. Building on previous work by other scholars, Slivon and her colleagues explain the linguistic actions of request and promise (Winograd and Flores, 1986). "A request is an action that a person takes by speaking" (Austin et al., 1975, as cited in Slivon et al., 2010, page 4). Another person, receiving the request may respond to it by making a promise. Vrijhoef and his colleagues (2001, page 1) contend that many of the problems associated with the construction supply chain arise from the "poor articulation and activation of commitments". Although physical activity is needed to fulfil a promise, it is in the network of these commitments that the participants' activities take place (Slivon et al., 2010).

Dubois and Gadde (2000) refer to studies of customer-supplier collaboration, where great effects have been achieved by firms adapting to each other. A higher degree of integration will solve many of the problems associated with fragmentation (Dainty et al., 2001a, Gray, 1985). To foster such integration arenas and space for involvement of project participants are crucial (Auch and Smyth, 2010).

2.3.9 Discussion on conflict

The degree of conflict is used as an indicator of collaboration in this research. The construction industry is reportedly ridden with conflicts and both academics and practitioners emphasise the need to reduce the levels of conflict, and encourage trusting and fruitful collaboration instead. Still, the term conflict needs some attention. It is imperative to foster collaboration so that partners in construction projects spend less time arguing, inside or outside courtrooms, and such an interpretation of the term conflict may be understood as the opposite of collaboration. However, an alternative interpretation of the term points to conflict as the opposite of consensus. Stakeholders enter construction projects with specific interests or objectives in mind, most commonly economic interests. The stakeholder may hold certain views as to how to meet these objectives. As such, conflict may be understood and treated as constructive contributions to implementing the project, in that all stakeholders bring their expertise into the project.

Young (1989, page 188) argues that research into organisational culture needs to focus more attention on the "dynamics of relationships between organizational interests". He protests against the view that superior organisations are characterised by the encouragement of shared meanings (Peters and Waterman, 1982) attained by the internalising of uniform corporate values. Assumptions made about a collective identity are criti-

cised by Young as constituting a "single faceted view of individual motivation and social relationships in general" (1989, page 189). Other perspectives capture the recognition of plural interests, however, focusing highly on unilateral objective attainment and distinction (Young, 1989). In Young's view, these two approaches to organisational culture do not represent two radical alternatives, but rather conflicting emphasis on collectivity on the one hand, and resistance and distance on the other hand. Young demonstrates his point with reference to his longitudinal research into a small manufacturing business in the northern UK. A seemingly unified and collective identity in the workforce is recognised at first, captured in organisational events, only later on in the research to be revealed as diverse set of interests within the organisation – underlying multiple beliefs and values regarding the same events. As summed up by Young (1989, page 202): "The manifestations of organisational culture carry multiple meanings, capable of emphasising both unity and distance".

Another term that illustrates Young's point on unity on the one hand versus divergence in interests on the other hand is *opposition*, as a variant of conflict. Falkum (2007) observes that opposition is an attempt to weaken the causal relationship between power and performance within a system (organisation). Opposition itself may arise from different understanding of reality, a fear for having their own interests weakened, or a disagreement over form of government and power distribution in itself. The term opposition follows the term power, in that power means that someone can make decisions for others, a relationship that in itself leads to inequality. This inequality forms the basis for opposition. Opposition is in fact the historic basis for the formation of trade unions (Falkum, 2007). Falkum argues that management may stimulate greater support, commitment, initiative, participation and enthusiasm from staff by inviting employees (opposition) to influence strategies, development and problem solving in daily operations.

The above discussion on facets of conflict addresses several important issues that may guide this research. The first main point is the notion of the depth of which research should be designed to detect and separate superficial impressions from underlying meaning and opinions. The second main point emerging from the above discussion is the notion that conflict, referred to here as opposition, is not always negative and something to be eliminated. Opposition – bringing other interests, solutions and agendas to the table – may be viewed as a valuable benefit in terms of managing construction operations.

Research by Blackler and Brown (1980) may serve to demonstrate the results from not bringing the opposition to the table. They researched the Shell UK's philosophy program in the 1960s and showed how fragile a top-down change programme may be. They studied the implementation process of Shell's philosophy statements from the viewpoint of both individuals and organisation. The philosophy statement referred to top management's efforts to manage culture through a statement.

Their case study showed that management based on values failed to obtain an organisation-wide commitment to such statements. In promoting values, behavioural commitment is thus more important than oral and written communication concerning the desired outcomes. This was demonstrated in the Blackler and Brown study as the implementation turned out to be rejected by employees.

The philosophy statements were produced and stated to employees in seminars. A series of job redesign projects were implemented at the departmental level. The authors' judgement of the programme was that it failed to change the culture in Shell based on several accounts, including the underestimation of the need to involve people and to back the change programme with the proper resources (Moland, 2007) to implement the changes.

2.3.10 Indicators of collaboration in construction projects

The six broad categories of collaborative indicators, or *dimensions*, established for this research were derived from an initial review of the literature in developing the research proposal for the current research. The literature concerned changes towards a collaborate culture in different fields of research. These were a) familiarity and common goal setting; b) involvement and communications; c) conflict; d) motivation; e) awareness of each other's perspectives; and f) predictable working processes (Hult et al. 2004; Jørgensen et al. 2004; Johansen and Porter 2003; Bohm 1996; Habermas, 1991; Rommetveit 1980; Boland and Tenkasi, 1995; Fiedler and Deegan 2007; Ballard 1998). Also, previous research by the author supported the established dimensions (Skinnarland and Moen 2010).

Following the initial establishment of the six collaborative dimensions, and building on the initial review of the literature, a thorough literature review was carried out. The aim was to validate the chosen dimensions with a broader search for dimensions of collaboration, and to search for indicators to be used to operationalise the six dimensions. No new dimensions were established in the thorough literature process; however, 54

indicators were derived, which constituted nuances that could be qualitatively sorted under the six dimensions.

Table 2.2 on the next page compiles the findings of indicators described in the literature. Given that there were some thematic overlaps, and that nuances in the indicators existed, all are included in the table. In the author column, a sample of work is listed from which indicators have been drawn. The indicators have also been sorted by type of indicators, whether related to value and attitudes, behaviour, relations or organisation and production.

The indicators derived from the thorough research were transformed into statements about collaboration later to be used in the pilot survey questionnaire. The aim was to statistically reduce the number of indicators and perform tests of internal reliability, see page 61. The 54 indicators derived from the literature as referred to above, were subsequently included in the pilot study and statistically reduced to 15 indicators, based on a Cronbach's Alpha test in conjunction with a qualitative assessment. These 15 indicators, see section 3.6.1, were later used to operationalise the six dimensions following both a qualitative sorting of the 15 indicators under the six dimensions, together with a statistical re-confirming factor analysis.

Table 2.1 may serve to summarise and illustrate the process of establishing dimensions, underlying indicators and ultimately the indices, or dependent variables, of collaborative relationships used in this research.

Step	Action	Result
1	From initial literature review	Dimension 1, 2,…, 6
2	From a thorough literature review	Indicator 1, 2, 3,…, 54
3	New dimensions of collaboration emerged?	No
4	54 indicators transformed into statements about collaboration tested in pilot study	Example: I find that collaborative planning contributes to contractors working as one team
5	Reduction of indicators by Cronbach's Alpha test of internal reliability	54 indicators statistically reduced to 15 indicators
6	Qualitative sorting of 15 indicators (In) by dimensions (D)	In1+In2=D1; In3+In4=D2 In5+In6=D3; In7+In8+In9=D4 In10+In11+In12=D5; In13+In14+In15=D6
7	Reconfirming factor analysis to statistically confirm qualitative sorting and thereof establish six indices (Dependent variables)	Confirmed, and dependent variables established
8	The indexing of the six dimensions	See page 76

Table 2.1 Process of establishing dimensions

Source: author.

Indicators	Description	Examples	Grouping examples	Authors
Value and attitudinal indicators	Describe how the group participants view themselves and others in the relation-ship	Unselfish contribution Open minded culture/openness Responsibility Explicit mutual commitment Group based trust Calculus-based trust Knowledge-based trust Identity-based trust Willingness to share infor-mation Equitable relationships Respectful relationships Living with ambiguity Perspective sharing Willingness to learn and change Reflection Empathy Motivation Self-awareness and awareness of the others	These indicators reflect the groups' abilities and willingness to give to the group, receive from the group, and share with the group; openness, responsibility, commitment, learning and trust, and to foster equality and respect and increased awareness	Browning et al. (1995) Doz and Baburoglu (2001) Baiden et al. (2006) Gottlieb and Feeley (2006) Gray (2000) Skinnarland and Yndesdal (2010) Jørgensen et al. (2004) Fiedler and Deegan (2007) Preece (2004) Boland Jr. and Tenkasi (1995)
Behavioural indicators	Describe what the group participants do	Joint problem solving Operating as a team Early conflict resolution (early) discussions and speech behaviour/communicative actions Emergence of constructive norms Norms of reciprocity Degree of diversity in contribu-tions Extent of active participation by multiple groups Information sharing Offer equal contribution Sharing of expertise/knowledge Active participation Level of engagement Dialogue	These indicators reflect the groups' abilities and willingness to appear as a cohesive group, to engage in activities that integrate the participants' efforts to the best interest of the overall project	Browning et al. (1995) Doz and Baburoglu (2001) Baiden et al. (2006) Gottlieb and Feeley (2006) Gray (2000) Skinnarland and Yndesdal (2010) Jørgensen et al. (2004) Johansen and Porter (2003) Reagle (2008) Bohm (1996)
Relational indicators	Describe the nature of the relationship within the group	Sense of moral community Involvement Common ground Informal relationships Creation of shared meaning New identity and co-located A 'no blame' culture/non-judgemental and accepting Power sharing A feeling of familiarity and community Generation of social capital Group identity	These indicators reflect the groups' abilities and willingness to value the equality of the group participants to mature a sense of community and group identity	Browning et al. (1995) Doz and Baburoglu (2001) Baiden et al. (2006) Gottlieb and Feeley (2006) Gray (2000) Skinnarland and Yndesdal (2010) Johansen and Porter (2003)
Organisational indicators	Describe how the group organise collab-oration to approach production	Structured meetings Communications structures Formal structures Changes in network structures Redistribution of resources No. of goals achieved/mutually agreed on goals Single focus and objectives Boundary free operations Predictable estimates Flexible member composition	These indicators reflect the groups' abilities and willingness to establish structures, rou-tines and framework to work towards common goals and objectives	Browning et al. (1995) Doz and Baburoglu (2001) Baiden et al. (2006) Gray (2000) Skinnarland and Yndesdal (2010) Habermas (1991)

Table 2.2. Collaborative indicators, based on literature review.

Source: author.

The review showed a limited number of explicit indicators of collaboration. Jørgensen et al. (2004) refer to a Danish case-study where a large construction project was monitored over several months in 2002. A change in the collaborative culture was indicated by the change in reported levels of conflict, mistrust and problem solving. Involvement indicators were emphasised as a means to develop a collaborative culture in two large construction projects in the UK, and Johansen and Porter (2003) point to the need to engage the whole team, including client and designers, and to engage the 'front end' managers in planning, including subcontractor managers. Sharing of knowledge and information are other key indicators of a collaborative culture (Reagle, 2008). Information is words expressed within a cultural framework (Hofstede et al., 2010). Other authors have emphasised the importance of dialogue (Bohm, 1996), communicative action (Habermas, 1991), empathy (Preece, 2004), and perspective making and taking (Boland Jr and Tenkasi, 1995, Rommetveit, 1980) in developing a collaborative culture. "An essential component of communicative competence in a pluralistic social world […] is our capacity to adopt the perspectives of different 'others'" (Rommetveit, 1980, page 126). Collaborating and building on multiple knowledge and expert domains in multi-disciplinary endeavours require that members are able to take each other's perspectives (Boland Jr and Tenkasi, 1995). Fiedler and Deegan (2007) highlight the motivational aspect of collaboration within the building and construction industry. Shelbourn and colleagues (2006) hold that good collaboration does not result from the implementation of technology alone. They emphasise the need to adapt and combine both 'soft' (i.e. organisational and cultural) and 'hard' (i.e. technological) concepts and tools. Gottlieb et al. (2005) highlight power sharing, openness, respect, a non-judgemental environment, tolerance of ambiguity and uncertainty, and levels of self-awareness and reflection as signs that a collaborative partnership is taking place. The authors find shared vision, engaging all key participants, building trusting relationships, communicative means to collaboration, routines and procedures (processes) and an agreement on the use of technologies to be used as a basis for developing collaborative culture.

Baiden and Price (2011) find that integration is useful for teamwork effectiveness and Baiden et al. (2006) identified effective practices in integrating teams by award winning construction managers, in terms of practices leading to full or partial integration, or to fragmented work. Baiden et al. (2006, page 14) consider integration as "the merging of different disciplines or organisations with different goals, needs and cultures

into a cohesive and mutually supporting unit". Current research explored the processes needed to achieve integration.

Browning et al. (1995) were focusing on the semiconductor industry when setting up a five-year research consortium programme, Sematech, in 1987. The aim of their research was to explore how cooperation could be established and sustained, especially taking into consideration the very competitive nature of the semiconductor industry. Based on grounded theory, and qualitative methodologies, they showed how such phenomena as competition, cooperation and change, "came together to influence Sematech founding and early functioning" (Browning et al., 1995, page 138). According to Weick (1979), organisations move from a state of equivocality to structure. In the formation phase, there was also a mixed conception of culture, and some even felt the five-year consortium was too short a period within which to try to build a cooperative culture. In the second phase, the authors described how various elements, such as inclusiveness, informality and crucial contributions, in particular by their devoted charismatic leader, enabled a moral community to emerge. And last, according to Browning (1995, page 137), the structuring "was […] a product of the cooperation" and the new structures in turn allowed for even more cooperative behaviour to occur.

The three sets of social conditions described by Browning et al. (1995) were factors that helped create the collaborative culture. Although the authors' main concern was how the formation and activities enabled cooperation, not only within the consortium, but also industry-wide in spin-offs from this joint effort, the manifestation of collaborative behaviour was also apparent. Collaboration was indicated by, e.g. joint problem solving, operating as a team, sense of community, inclusiveness, discussion and speech behaviour to mention a few. Browning's article resembles recent research conducted within the construction industry (Skinnarland and Yndesdal, 2010). First, uncertainty and ambiguity accompanying new organisational establishments also apply to setting up new construction projects. New roles, strategies and structures are established. A new product results from some form of collaborative activity, with a new set of project participants that enter the project with their values, believes, and past experiences (Howell et al., 2004) and thus a perception of how to behave emerges in the new project (Skinnarland and Yndesdal, 2010). Skinnarland and Yndesdal's case study, which explored how collaboration can develop within the construction industry, suggested three phases, although developing in loops, as new entrants to the building site necessitates repetition of previous phases. The three phases Skinnarland and Yndesdal refer to are the initialising phase, reinforcement phase, and a routine phase. In the first phase, the

project manger's role, to initiate collaborative behaviour and particular events was evident to enable early involvement. In the second phase, reinforcement of collaborative behaviour took place as project participants themselves experienced positive effects, making them want to collaborate more. In the third phase, this collaborative behaviour spiralled into a routine and 'the way we do things'. The research of both Browning et al. and Skinnarland and Yndesdal show the reinforcing effects of collaborative behaviour and structures, and both also point out the crucial role of the management in building the trust and motivation necessary for collaboration to occur.

Many authors provide useful insight into the factors or conditions necessary to foster collaboration (e.g. Browning et al., 1995, Van de Ven, 1976), or the processes of developing cooperation (Ring and Van de Ven, 1994) and the positive results of collaboration (Bresnen and Marshall, 2000). There exists only a limited amount of research, however, which explicitly points out measures that indicate collaboration. How collaborative activities or behaviour are manifested, is a question that goes unanswered, as does the question of what kind of proof exists of collaboration taking place. In this research, therefore, valid indicators of collaboration were established based on implicit and explicit findings from previous research.

As pointed out in chapter 1.6, on page 6, the use of indicators has limitations in the very nature of the relationship in terms of cause and effects. Further, it may be argued that the 15 indicators, sorted under the six dimensions of collaboration, all may constitute either a manifestation, or proof of collaboration, or as outcomes of collaboration. However, in current research, the indicators are treated as the former, rather than the latter.

2.3.11 Summary

In this chapter, the relationship between the main contractor and subcontractors has been addressed. Several authors have described the adversarial culture characterising this industry (Egan, 1998, Harvey and Ashworth, 1993, Saad et al., 2002), and authors propose that more collaborative efforts are needed if the adversarial relationship is to cease. However, there are few reports that specifically address *how* to achieve increased collaboration between contractors participating in a project.

When addressing the particular relationship between the contracting partners directly involved in the production on site, authors find multiple barriers to collaboration.

Several authors have offered insightful studies regarding the main contractor subcontractor relationship in terms of game theory (Axelrod, 1984, Sacks and Harel, 2006). A

pattern of *act-react* interaction unfolds, which develops the relationship between the actors over time (Sacks and Harel, 2006).

Partnering attempts have increased in the construction industry (Briscoe et al., 2001). Selection of subcontractors has traditionally been based on the contractors' individual performance, rather than their abilities to integrate their work efforts. Contracts (Briscoe et al., 2001, Shimizu and Cardoso, 2002) have mainly been used to govern the relationship between main contractors and subcontractors. Contracts are used to protect against opportunistic behaviour in alliances, reflecting the partners rated risk levels, according to Gulati (1995).

Many authors have discussed the role of trust in the main contractor subcontractor relationship (Zaghloul and Hartman, 2003, Huemer, 1994), and addressed ways in which trust may be built and sustained (Vrijhoef et al., 2001, Huemer, 1994, Howell et al., 2004, Uzzi, 1997). In selecting partners for construction projects, trust has evidently become a growing element upon which the selection process is based (Eccles, 1981). This is particularly true in repeating alliances (Gulati, 1995).

Indicators of collaboration are rarely found explicitly, but rather implicitly in the literature. The review has revealed a number of indicators reflecting collaboration in, e.g. health care partnerships (Gottlieb et al., 2005), research consortium programmes (Browning et al., 1995) and construction projects (Baiden et al., 2006). Neighbouring concepts such as integration (Baiden et al., 2006) and cooperation (Browning et al., 1995) are frequently used instead of the term collaboration.

2.4 Project Management and progression planning tools

2.4.1 Introduction

In this chapter, the literature on project management is reviewed, and the progression planning methodology, which serves as a basis for this research, is introduced.

Culture has been found to have a great impact on sustained competitiveness (Cameron and Quinn, 2006). They argue that the tools and techniques that an organisation applies in their operations do not directly influence their competitive advantage; rather, these are applied to support and to reinforce their cultural cohesion.

Researchers have become increasingly occupied with understanding the concept of organisational culture and its influence on construction management practices (Loosemore and Muslmani, 1999). Kerzner (2009) argues that project management "has become a business process and not just a project management process". This means that firms organise their overall operations based on project production and view project management as mandatory for survival. A starting point for discussing project management is to elaborate on what a project is. According to Kerzner (2009), projects are activities or tasks carried out within certain specifications and with specific objectives, using both human and non-human resources. Projects have specific time frames and funding limits. The project based way of organising work has increased in many industries (Lundin and Stablein, 2000). The construction industry share, with many other industries, such as advertising, biotechnology, computers, and film and theatre, an organised temporary collaboration between two or more organisations (Jones and Lichtenstein, 2008, Kenis et al., 2009). Construction projects are temporal in nature and formed on a case-to-case basis.

Project management as a way of running a business has gained popularity since the early 1960s (Meredith and Mantel, 2009). Increasingly, organisations have been forced to adapt to developments in markets and technology, and project management has been used as a means to accomplish organisational change. One such development is advanced 3-D modelling in planning operations. Building Information Modelling (BIM) is increasingly impacting the construction management profession (Jackson, 2010). BIM technology offers a digitally constructed accurate virtual model of a building. BIM is a new approach to design, construction and facility management (Eastman et al., 2008). The authors claim that BIM represents a paradigm shift and that rather than

thinking of BIM as software, BIM is a human activity that will change the processes in construction.

2.4.2 Project manager role and competence

The increasing emphasis on the use of subcontractors in construction projects not only adds to complexity, but also highlights the widely accepted importance of emphasising the human and relational aspects, and not only the quantitative and hard-fact aspects of carrying out projects (Kerzner, 2009, Meredith and Mantel, 2009). As Walker (2007, page 2) expresses it, "The key to the management of construction projects is [...] the way in which the contributors are organised so that their skills are used in the right manner and at the right time for the maximum benefit to the client".

To lead and to motivate the workforce are often critical skills (Briscoe et al., 2001) and in relation to skilled workers, team supervisors are crucial for changing culture (Seymour and Hill, 1996). Rapid interactions, such as face-to-face meetings, can, however, facilitate shared understandings (Daft and Lengel, 1986). Thus, supply chains require continuous information distribution in order to maintain strategic, operational, and technological integration (Hult et al., 2004). A chain wide emphasis on discussions, meetings, and information sharing may help fill a key role that culture serves for organisations, that of providing familiarity and the opportunity to develop a common mind-set about issues (Hult et al., 2004).

Adding to the need to address the social factors of project management, these factors are not static, but often shifting throughout the life span of the project. As Auch and Smyth (2010, page 455) express it, "culture is dynamic and constantly being renegotiated by individuals, groups and teams". For construction project managers this means that they should play an active role in the formation and negotiation of collaborative culture. Levy (2006) addresses the project managers role in the construction process as a key player. Besides being technically competent the project manager "must possess the management skills necessary to effectively control the teams of subcontractors, vendors, and field personnel required to provide the smooth flow of trades people and materials needed to get the job done" (Levy, 2006, page xiii). A valid question can be raised concerning the necessity of including such a variety of management skills in the formal education of project management. This, however, is outside the scope of this thesis.

In the early phases of establishing the building project, the project manager has a crucial role in initiating an early development of collaboration (Skinnarland and Yndesdal, 2010). Skinnarland (2011) found that involving key personnel in driving the

collaborative efforts is decisive from the outset of projects. In the early phase of setting up the project, the project manager may involve lower managers who have good people skills, to deal with involving people in the project (Bee and Bee, 1997, Skinnarland, 2011).

Traditionally the construction project manager is formally trained more in engineering than in managing people. This last part may be perceived as 'coming with the job'. Cheng et al. (2005) identified the competency profile of the superior manager role. Statistical techniques were used to identify 12 core behavioural competencies that underpin effective project management performance: achievement orientation, initiative, information seeking, focus on client's needs, impact and influence, directiveness, teamwork and cooperation, team leadership, analytical thinking, conceptual thinking, self-control and flexibility. Gray and Larson (2000) stress the role of the project manager in shaping a collaborative culture by stimulating teamwork. Levy (2006) points out that the only constant in a project manager's daily routine is change. Project managers in construction projects need to receive and integrate newcomers throughout the projects, as subcontractors start and finish their jobs at different stages. This is particularly challenging considering the pressure to deliver results to tight time-schedules without the luxury of a gentle period of adapting (Bee and Bee, 1997) to tasks and people.

2.4.3 Uncertainty and variability in construction projects

Some degree of uncertainty will always persist in construction projects. Good collaboration skills make it possible to mitigate some of this uncertainty by involving more people in the progression planning process (Skinnarland and Moen, 2010). Project management's ability to manage projects characterised by uncertainty and conflict is crucial to the outcome of the project (Conte, 1998). Conte refers to a project in São Paulo in Brazil, where concepts related to Lean Construction were implemented. A successful construction project is carried out in accordance with plans, and a solid plan is a plan that a) predicts the correct sequence of activities, b) predicts the correct quantity of labour and delivery, and c) enables the planned work to be effectively implemented. The high degree of uncertainty in construction necessitates a project management with a will and skills to make necessary adjustments to the plans. Several authors, both academics and consultants, have examined the issue of variability in construction and its impact on project performance (Horman et al., 2002, Ballard and Howell, 1994, Shen and Chua, 2005). Horman et al. suggest a two-level approach to dealing with variability in construction. First, one needs to reduce the kind of variability that is caused by unre-

liable flows to an acceptable level. The terms flow, or production flow (Koskela, 2000), increasingly appears in the construction management literature, yet it seems that 'flow' often is based on a universal perception of a pictorial flow more than the existence of a definition of the term. The second approach to dealing with variability is the use of effective workforce management strategies that may be employed to manage the remaining system variability. The variability in construction projects also affects how performance can be measured. Companies relate productivity to project management. Chan and Kaka (2004) argue that the measure of productivity is a subset of the wider measure of performance.

2.4.4 Progression Planning Tools

This research aimed to explore whether project management's collaborative progression planning tools can be used to increase the degree of collaborative relationships in construction projects. Tools can be understood in terms of physical tools, routines, structured meetings etc. Tools can also be understood in terms of relational tools, or resources, capabilities of managing relationships. Put differently, collaborative planning in this research refers to the tools and structures employed, thus answering the 'what' question. The equally important question is 'how' collaborative planning is managed as a form of collaboration. Regarding the latter issue of collaborative planning, the processes of involving the project participants were explored.

According to Lewis (2007), there is a preference for acting and not for planning in the USA. This assertion seems to hold globally. Lewis (2007, page xi) contends that "we just want to get the job done, and planning is often viewed as a waste of time."

Still, the construction industry spends vast amounts of resources on planning projects and developing the time schedules, budgets and other requirements "that collectively tell project personnel what they should do" (Ballard and Howell, 1994, page 2). However, there seems to be an imbalance in this respect between larger and smaller construction companies. Planning and scheduling processes are commonly directed by the lead firm in construction, often the general contractor in design-build projects (Jones and Lichtenstein, 2008). Briscoe et al. (2001, page 248) assert that "many small construction organisations have not, historically, exhibited high levels of proficiency in the planning disciplines".

2.4.5 Lean Construction

Over the last two decades, lean thinking has been adapted and developed in the construction industry as a "way to design production systems to minimise waste of materi-

als, time, and effort in order to generate the maximum possible amount of value" (Koskela et al., 2002, page 211). Authors point to means and effects of building a collaborative culture. Lean thinking is claimed to influence the culture of collaboration (Howell and Ballard, 1998, Egan, 1998).

Lean Construction (LC) (Ballard, 2000, Koskela, 2000) is a collective term for theories and practical planning tools related to site production in construction, inspired by Toyota manufacturing principles. Lean Construction is adjusted to the characteristics of production and logistics in construction. In practice this means that it is no longer central planners in the corporate organisation, but the team supervisors and their teams (Last Planner System) that will pull tasks to the weekly work plans when they are ready for execution. The reasoning behind this adjustment is that this kind of production requires a short planning horizon due to interdependency and variability (e.g. a six-week rolling phase plan in combination with weekly work plans).

Lean thinking is based on the five principles of *value*, (the value associated with the product as specified by the customer); *value stream* (identifying the value stream for each product and to avoid waste); *flow* (to create a value flow without interruption); *pull* (to let customer needs guide the production process); and *continuous improvement* (creating a continuous improvement throughout the process), as put forward by Womack and Jones (1996). Koskela was a pioneer in using the ideas of Lean Production in construction site production (Shimizu and Cardoso, 2002). Koskela (1999) argues that little emphasis has been placed on theory development and project management as a discipline within construction. Koskela and Howell (2002, 2008) challenged the traditional manufacturing paradigm in project management by demonstrating that the underlying theory is outdated. Bertelsen and Koskela (2002) promote the need to bring together a new theory about construction based on the theories of transformation, flow and value generation. A one-sided focus on transformation theory to understand project management creates, according to Koskela et al. (2003), self-reinforcing problems due to a lack of awareness of uncertainty and dependency between trades. This problem was pointed out by Tavistock Institute as early as in 1966 (Higgin et al., 1966).

Howell et al. (2004) point out that projects are initiated and implemented by people who find themselves at the beginning, in the middle and at the end of projects. According to Howell, we still lack a comprehensive theoretical foundation that explains how project management can fully involve and engage people. It is generally accepted that there is a need for change in the construction industry (Koskela et al., 2003). The construction industry has been under pressure to change for many years and many initia-

tives for change have been tried, but few have succeeded. Changes must start in the operational processes that create the end product, which is the production (Koskela et al., 2003). Further, change processes should consist of small steps in the right direction, where limited and fragmented initiatives are gradually strengthened and made more systematic (Howell et al., 2004).

2.4.6 Last Planner System

The Last Planner System is "a control system, [...] that causes the realisation of plans, and thus supplements project management's concern for management of contracts with the management of production" (Ballard, 2000, in abstract). One of the principles for a production control system is lookahead planning (Ballard, 1997, Koskela, 1999, Hamzeh et al., 2012). With high uncertainty concerning delivery information and time requirements it is difficult to plan in detail far ahead of the work activities. Therefore, shorter planning horizons are used. Lookahead plans fill the gap between the master plan for the entire project and weekly work plans. The main objective of lookahead planning is to create healthy activities. This means to remove any obstacles from execution of activities, so that activities, when they are transferred to a weekly work plan can actually be implemented. Traditional weekly work plans have proven to be less reliable (Ballard and Howell, 1994), thus imposing uncertainty and unreliability on downstream production. The idea behind lookahead planning is to create a more predictable workflow, to adjust workloads to resources, identify individual operations or tasks, and to build up a buffer of healthy activities. According to Ballard (2000) the Last Planner System increases reliability in three ways. First; through the lookahead planning and preparation process, second; by filtering weekly activities to ensure that the previously planned work is completed, and third; by involving and committing managers and employees.

Ballard's description of the purpose and the use of lookahead planning is supported empirically by Fiallo and Revelo (2002), among others, who reported from a case study in Ecuador that the project management experienced the Last Planner System to be a useful planning tool. Lookahead planning enabled the coupling of activities in the coming weeks with the master plan of the project.

Iterative planning is a means by which the risk inherent in large, complex processes is reduced (Slivon et al., 2010). The Last Planner System reduces risk by making workflow more predictable. According to Slivon et al. (2010, page 9) "planning can be understood as a conversation in which the interests and concerns of all parties are articu-

lated, discussed, and aligned, and commitments to action are made. These concerns will shift and evolve as the project proceeds and as constraints become evident". Indeed, Vrijhoef and his colleagues (2001, page 5) claim that "basically, business processes are sequences of commitments between authorised and responsible social actors or individuals". They studied the Last Planner System from a language/action viewpoint, which they contend resembles the main ideas behind the language/action perspective. The Last Planner System provides a structure for conversations, clarity regarding assignments, elicits task commitment, declaration of completion and pinpoints any breakdowns (Vrijhoef et al., 2001). As a system providing for such a conversation structure, the Last Planner System is a means to achieve a high-commitment, high-trust construction supply chain. "In practice the Last Planner may induce a series of events that corresponds to the description of small wins" (Vrijhoef et al., 2001, page 12).

The Last Planner System is related to planning and not as a means of measuring on-site productivity. One of the Key Performance Indicators (KPI's) in The Last Planner System is the PPC, or percent plan complete. Some authors view this KPI to be valuable in terms of gaining information about the on-site productivity levels (Chan and Kaka, 2004) whereas others strongly advise that the PPC should provide information about the plan reliability (Ballard, 1999).

Implementation of Lean Construction and the Last Planner System

Implementing Lean principles involves a process of change (Arbulu and Zabelle, 2006). Arbulu and Zabelle argue that implementing Lean has little to do with Lean concepts and techniques, but is rather an organisational challenge that requires a development strategy and commitment from all actors. The development process should be based on this knowledge and acknowledged by the corporate management before construction projects implement lean principles (Skinnarland and Moen, 2010). Change processes without such a basis are more likely to fail (Trygstad et al., 2006, Moland, 2007).

Planning is an important factor in the successful construction project (Friblick et al., 2009). A major issue when implementing the Last Planner System is a lack of knowledge about the methodology among managers. Thus, managers are uncertain about the use of the Last Planner System and of which advantages the method can provide. Friblick and his colleagues (2009) emphasise the necessity to involve all participants in the planning of the project rather than leaving the planning to the project management alone. Even subcontractors and workers should participate in short-term project planning. The involvement of subcontractors and workers in progression plan-

ning will increase the reliability of the production schedules since these actors are closer to the production, and thus most informed about events in the production, which could affect the progress (Friblick et al., 2009). Friblick and his colleagues found that few subcontractors were involved in planning. It is difficult to identify reasons for the low level of involvement among subcontractors, but Johansen and Porter (2003), who examined UK construction projects where the Last Planner System was implemented, found that getting the subcontractors to adopt the Last Planner System was culturally conditioned. Structural and cultural barriers to Last Planner System were identified. Some of the respondents in the British study, in spite of having received training in LC and Last Planner System, did not accept that there was anything wrong with the traditional way of planning construction projects. A large proportion of the site production in the United Kingdom is carried out by subcontractors. When subcontractors show little willingness to commit to the project, it may partially be explained by a large pressure on bidding prices in their contracts. The solution to the problem is more training (Johansen and Porter, 2003). Johansen and Porter also discuss whether the Last Planner System may need a higher contractual liability followed by stringent fines. At the same time, they are aware of the paradox posed by the possible negative effects of such a contractual form on the 'no blame' philosophy of the Last Planner System.

Skinnarland (2011) reports on an opposite experience in a Norwegian construction project. The problem with getting subcontractors involved in the planning was absent. On the contrary, data suggest that subcontractors embraced the way they were involved in the project. Becoming more involved in progression planning gave them greater control of their own progress and an overall understanding of the project. Child and Faulkner (1998) point to control as a sensitive matter. They assert that control of collaboration largely depends on the relationship between the partners and less on contractual foundations.

Any resistance to getting involved may be explained by the degree of involvement and the way in which subcontractors are involved, as well as on their own perception about the relationships between project participants (Skinnarland, 2011). The Norwegian study points out that the project management from the outset of the project stated an expectation of subcontractor involvement and commitment towards joint progression plans. However, what proved equally or even more important to collaboration on site, was the participants' early positive effects of involvement. Instead of executing sanctions when deviating from joint plans, the project management chose instead to show understanding, flexibility and tolerance towards subcontractors, and thus achieved a

partnership free of conflict. The research noted above reveals that there may be appropriate arguments for rejecting the suggested approach to regulate involvement through the use of contractual sanctions (Johansen and Porter, 2003).

Reliability is an important factor in all construction projects. Kim and Jang (2005) reported that the Last Planner System improved workflow reliability. Project managers need more experience and knowledge about how to implement the planning processes to facilitate increased work flows (Kim and Jang, 2005, Friblick et al., 2009).

Auada et al. (1998) describe positive effects of implementing the Last Planner System in Brazilian projects, such as reduced time, reduced waste, little rework and limited waiting.

Few studies of the implementation of Last Planner System have addressed the social aspects of Lean Construction (Coffey, 2000, Andersen et al., 2008). Successful implementation of Lean Construction depends on employees' ability to make use of Lean Construction tools and principles to achieve the potential of the methodology. Coffey (2000) therefore, stresses the aspects of involvement and commitment among employees in construction projects. Involvement is an active manifestation of commitment. Involvement is based on the employees' ability to participate in joint decision making processes concerning their own activities. The degree of sincerity and genuine participation in such processes is a test of the involvement level. Employees generally have a desire to be involved in decisions concerning the organisation of their own work, and the construction industry does not differ from other industries in this respect. Gradual and positive experiences strengthen the participants' own interest in further involvement (Skinnarland, 2011). This finding supports Vrijhoef and his colleagues (2001, page 12) who refer to implementation cases that demonstrate that "first enforced changes in behaviour led to changes in understanding and then voluntary changes in behaviour". They describe this as a snowballing effect of small wins.

Elsborg et al. (2004) analysed the findings from a Danish Government initiated Development Programme, BygLOK, with particular interest in the development processes involving the workers to a greater extent in daily decision making. The BygLOK programme was about leadership, organisation and competence in the construction industry. Employees and managers were especially positive to the increased use of each others' expertise. The Danish workers described positive effects such as increased respect and cooperation between trades and within the hierarchical structures, improved information sharing and communication, as well as being involved in the decision making process and able to take part in joint responsibility for the development of the project.

BygLOK established a structure that enabled collaboration across disciplines, and trades became more interested in the work. The work became more satisfying and challenging, and the participants showed enthusiasm in progression planning meetings. The Danish study shows the potential for collaboration between managers and workers and the development of common ownership of the production process. Such processes require systematic awareness and facilitation to avoid relapse into old behaviour (Elsborg et al., 2004). The development was clearly related to participants' immediate experiences in the process. Positive experiences of involvement give employees increased interest in becoming involved and to make use of their expertise in the process. Thus participants are willing to agree to a more committed form of collaboration in the implementation process (Elsborg et al., 2004, Skinnarland, 2011).

Other effects of the Last Planner methodology is improved execution time (Garcia et al., 2006) and flatter project organisations with a greater commitment by all participants in planning processes (Alarcón et al., 2002).

In a study of lean implementation in São Paulo, Conte (1998) showed that changes that called for each trade to make ready (tidy up and clean) their work area every day yielded positive effects. Additional effects of improvements concerning tidying and cleaning are increased efficiency, less damage of finished components, simplified material and equipment handling, and relational effects that improve collaboration, increase respect and understanding between project participants (Skinnarland and Moen, 2010).

Obstacles to implementation

There is little doubt that the implementation of Lean Construction and Last Planner Systems has created some positive results. At the same time several research articles suggest that Lean thinking and methodology still needs to be further developed. Researchers point to various causes of discrepancy between planned and conducted activities on the building site. Alsehaimi et al. (2009) refer to successful project implementation of Last Planner System in Saudi Arabia. To the extent that there were discrepancies between the plan and execution, this was due to previous work not being completed, a lack of manpower or equipment, or lack of clarifications and changes. Liu and Ballard (2009) report from a case study in the USA at an oil refinery plant, that the most important reasons for non-execution of tasks, was a lack of materials, previous work not being completed and execution prevented by the weather. Ballard and Howell (1994) point out that a problem in construction projects is that the roles of planning and control are often understaffed. In particular this may apply to small contractors.

Alarcón et al. (2002) refer to an experience with implementation of "Lean Planning" in Chile. Twelve projects were included in the study. The implementation process started when most projects were already underway. The researchers argue that this experience demonstrates that activities in the initiating phase of the building project generate changes in established relationships (Alarcón et al., 2002). The largest problem was a lack of time to implement new practices in projects that had already started. This resulted in only partial and intermittent implementation which resulted in inadequate preparation for the planning meetings. A lesson learned from the project was that the activities at the start of the project should have greater intensity to ensure an early and dynamic implementation. Another major problem was a lack of training and instruction in some of the projects. Training activities provide knowledge necessary to the project managers to enable them to complete the implementation process (Alarcón et al., 2002). Construction companies in Chile that simultaneously run other improvement programs, were more able to implement lean practises, and Alarcón ascribes this effect to the integration of both (or more) of the development programs.

Some of the project managers of the twelve Chilean projects demonstrated a fear of change and refused to include subcontractors in the planning meetings from the outset of the project (Alarcón et al., 2002). Alarcón et al further point to the project management's inability to be self-critical and a tendency to think in short term. This can be explained with reference to Sacks and Harel's (2006) game theory, where both main and subcontractors protect themselves by holding back information about resources and needs.

Johansen et al. (2004) investigated construction projects for two UK contractors. The analysis indicated that implementation of Last Planner System was hindered by a lack of attention to cultural, organisational and systematic barriers. The two case studies strengthen the general British perception (as pointed out by www.constructingexcellence.org.uk/) of two kinds of cultural barriers to successful construction projects. First, the problems are profound and historically rooted, and related to power imbalance, multiple loyalty considerations, differing interests and a lack of will to commit. Second, fragmentation and temporary production settings create mistrust and uncertainty. The British study insists that a cultural change is needed before any lean tools, (e.g. Last Planner System) can be implemented.

Research has shown positive effects in many lean implementation projects. Some of the larger contractors in Norway show an increasing interest in Lean Construction methodologies (Kalsaas et al., 2009). Still, there is relatively limited documentation of

implementation of Lean Construction. While Bortolazza et al. (2005) refer to publications with examples of successful implementation of Last Planner System, Kalsaas et al. (2009) warn against equating Lean Construction with implementation of Last Planner System.

2.4.7 Summary

Project management is more behavioural that quantitative (Granovetter, 1985). There has been increasingly more use of subcontractors (Kerzner, 2009) in construction, and such organising of business projects adds to the complexity of project management.

Many authors have emphasised the role of project managers as key players. His or her role is important throughout the life span of the project and is described as crucial in the initiating phase, for establishing collaboration early in the project (Skinnarland and Yndesdal, 2010).

The level of uncertainty and variability is high in construction (Horman et al., 2002, Ballard and Howell, 1994). These two elements may reinforce unreliable flows that result from poor planning of human and material resources (Koskela, 2000). Variability may also affect how performance can be measured (Chan and Kaka, 2004).

The temporality, fragmentation, and the complex relationships, together with high degrees of uncertainty and variability in construction require ability and willingness to properly plan production progress. However, construction people tend to want to get started without such proper planning (Lewis, 2007).

Lean Construction is a production management-based approach to project delivery. It has been developed as a way to design production systems to minimise waste of materials, time and effort, and to generate the maximum possible amount of value (Koskela et al., 2002). In fact, lean thinking, it has been suggested, influences the culture of collaboration (Howell and Ballard, 1998).

A prominent outcome of Lean Construction development is the Last Planner System for production control (Ballard, 1997). One of the principles for a production control system is lookahead planning (Ballard, 1997, Koskela, 1999), a methodological approach to remove obstacles for any activities scheduled ahead. This review refers to multiple researches based on implementation of the Last Planner system, both successes of such attempts and obstacles to implementation detected.

Chapter 3 Literature synthesis and generation of hypothesis

3.1 Literature synthesis

3.1.1 Introduction

This chapter synthesises the literature on culture and collaboration, relationships between main contractor and subcontractors, project management role and use of progression planning tools. There has been a growing interest in the understanding of culture and collaboration in the field of organisational theory and in the management literature in general. Evidence exists of an emergent emphasis on collaborative culture also in the context of construction projects. However, many of these latter reports are prescriptive rather than descriptive. As much as the need for better collaboration (Egan, 1998) is appreciated, and is even an assumption that serves as a starting point for this research into collaborative relationships, this research aimed to provide a deeper understanding of the processes involved in developing a collaborative relationship.

The literature review revealed that little is known about the direct link between progression planning tools, such as the Norwegian adaptation 'collaborative planning', and collaboration (or collaborative relationships) between contractors and subcontractors. In the review three different perspectives have been approached and explored, one which describes and defines the concepts of culture and collaboration (Chapter 2.2), one which explores what the literature has offered about the main contractor subcontractor relationship to the present day (Chapter 2.3), and one which deals with the project manager role, and describes the progression planning methodology used in this research, in a Lean Construction context (Chapter 2.4).

The concepts of culture and collaboration flourish in the organisational theory literature (Barthorpe et al., 2000, Kroeber et al., 1952, Bodley, 1994, Child and Faulkner, 1998, Schein, 1984, Weick, 1987, Hofstede et al., 2010), although there is relatively less related to culture and collaboration between organisations, and is limited in terms of construction projects (Zuo and Zillante, 2005). Much of what is available regarding conceptual understanding is based on research within organisations. In line with the

global business development, the management literature has also increasingly contributed to a variety of perspectives on understanding the collaboration between organisations; such as, e.g., supply chain management (SCM) (Bowersox et al., 1999, Hult and Ketchen, 2006), networks of organisations (Harland, 1996, Dyer and Nobeoka, 2000, Chen and Paulraj, 2004, Granovetter, 1985), the relational approach (Dyer and Singh, 1998, Rahman and Kumaraswamy, 2002, Kanter, 1994) , and IMP research (Huemer, 1994, Gadde and Håkansson, 2001). SCM has also been used as a framework for understanding relationships within the supply chain (or sometimes referred to as value chain), even within the construction industry (Vrijhoef and Koskela, 1999, Saad et al., 2002). Admittedly, though, supply chain relationships have either focused on the industry in general (Saad et al., 2002, Vrijhoef and Koskela, 2000) or on the relationships between phases of the building project, such as design and contractors (Love et al., 2004), owner and builder, and only to a limited extent on the relationship between main contractors and subcontractors (Dainty et al., 2001a, Wood and Ellis, 2005).

Research abound that describe the negative and adversarial relationship in the construction industry (Saad et al., 2002, Harvey and Ashworth, 1993, Egan, 1998). Authors describe the industry as being culturally ridden with conflict; it is fragmented; with a high degree of labour mobility; largely based on contractual agreements; as a crisis management culture; and a masculine culture (Hancock, 2000). There is considerable agreement about the need to improve the collaborative relationships in the industry, although insignificantly few studies describe how this can be accomplished. There seems, thus, to be a gap in the literature that must be filled in terms of the ways in which collaborative relationships can be improved, and in particular how the collaboration between main contractor and subcontractors in the execution phase may be improved. This research aimed to establish knowledge pertaining how the collaborative relationships between the contractors could be affected.

The literature review has shown that there are many barriers to achieving a good working relationship between contractors and subcontractors (Briscoe et al., 2001, Dainty et al., 2001a). These barriers may be related to varying levels of education and knowledge, to power imbalances in contractual relationships, and attitudinal elements in the relationship, to mention only a few. In the absence of research that investigate how such barriers can be reduced or managed, this project represented an attempt to close the knowledge gap by examining whether and how a specific planning methodology (collaborative progression planning), can help remove barriers to collaboration and instead build and support collaboration.

The progression planning methodology in this research is 'collaborative planning', based on a system of production control; the Last Planner System (LPS) (Ballard, 2000). Many studies have reported on more or less successful implementation experiments with LPS (Elsborg et al., 2004, Alarcón et al., 2002). These implementation studies intended to report on the implementation process (Skinnarland and Yndesdal, 2010), a change programme (Arbulu and Zabelle, 2006), and only a few have been concerned with the social aspects (Coffey, 2000, Andersen et al., 2008). No known reports, however, are explicitly directed towards studying the effect of planning methodology, (what and how) on the collaboration between the main contractor and subcontractor.

To systematically explore the collaborative relationships, the literature review also contains a review of indicators for such collaboration. Despite the very limited number of definitions of the term 'collaborative culture' in relation to the construction industry (Zuo and Zillante, 2005, Reagle, 2008), Montiel-Overall (2005, page 32) offers a definition of collaboration as a "trusting, working relationship between two or more equal participants involved in shared thinking, shared planning and shared creation". However, this definition does not reveal any knowledge of how collaboration is manifested in such relationships. Only a few studies have offered insight into collaboration indicators (Gottlieb et al., 2005, Baiden et al., 2006, Browning et al., 1995). The literature review contains more than 50 indicators extracted from previous research. Most of these have been extracted from reports on integration or cooperation attempts, and as such, only implicitly interpreted as indicators of collaboration. A reduction of indicators at this point was not appropriate, since there are no previous studies related to the scope of main contractor subcontractor collaborative culture, from which a set of tested indicators could be utilised. A pilot study was therefore conducted that statistically reduced the number and scope of indicators included in the operationalising of hypothesis tested.

3.2 The literature Synthesis

The literature suggests that the following relationships exist:

X is related to Y

Y is related to Z

X is related to Z

- X= various types of joint interaction, project group, inter-organisational team effort
- Y= various types of outcome; such as increased productivity performance, or other performance measures and goal attainment
- Z= various types of improved collaboration, group identity, cohesiveness

How X is related to Y

Researchers have increasingly studied collaboration from the perspective of two or more organisations' joint attempts at "deriving mutual benefits" (Chen and Paulraj, 2004, page 147). Attempts at understanding collaboration span from supply chain management (Bowersox et al., 1999, Harland, 1996, Hult et al., 2002, Hult et al., 2004, Vrijhoef and Koskela, 1999), networks of interdependent relationships that accommodate collaboration (Chen and Paulraj, 2004, Dyer and Nobeoka, 2000, Granovetter, 1985), to inter-firm relational approach (Løwendahl and Revang, 1998, Dyer and Singh, 1998, Rahman and Kumaraswamy, 2002) and the IMP approach (Industrial and Marketing and Purchasing Group, see chapter 2.2), (Huemer, 1994, Gadde and Håkansson, 2001).

In construction, concepts such as partnering and supply chain management (Egan, 1998, Briscoe et al., 2001), and Lean Construction (Koskela, 1992) have been suggested as means to improve coordination and integration between actors to enhance productivity performance. Innovative forms of contracts have also been reported as means to enable collaboration (Slivon et al., 2010). The Last Planner System, LPS, (Ballard, 2000) is a production control system aimed at increasing reliability in planning and achieving more predictable workflows. Empirical studies of implementing LPS have been conducted in many countries (Fiallo and Revelo, 2002, Friblick et al., 2009, Johansen and Porter, 2003, Skinnarland, 2011, Auada et al., 1998). Kim and Jang (2005) reported that the Last Planner System improved workflow reliability.

Doz and Baburoglu (2001) reported on alliances engaging in explicit mutual commitment and Dubois and Gadde (2000) referred to studies of customer-supplier collaboration to achieve the desired effects. Browning et al. (1995) studied a research consortium programme that was set up as a response to the threat by the increased Japanese market share in the semiconductor industry.

Conclusion: The literature shows that X is related to Y; in that various types of joint interaction, alliances, and inter-organisational project groups have been established

in order to achieve various types of project outcome; such as increased productivity performance, or other performance measures and goal attainment.

How Y is related to Z

Several authors have emphasised the importance of collaboration in achieving various types of project outcome, (Jørgensen et al., 2004, Egan, 1998), exemplified above as increased productivity performance, or other performance measures and goal attainment. Trust is seen as a central mechanism to achieving collaboration (Kerzner, 2010, Huemer, 1994, Sheth and Parvatiyar, 1995, McKnight and Chervany, 2001), and various means to build and sustained trust is offered (Vrijhoef et al., 2001, Granovetter, 1985, Slivon et al., 2010).

Other researchers have addressed possible barriers to collaboration. Barriers referred to in the literature are cultural barriers (Jørgensen et al., 2004), barriers in terms of the level of skills needed to operate partnerships (Briscoe et al., 2001), and barriers related to financial/cost, programming/time, quality of information and attitude (Dainty et al., 2001b).

Browning et al. (1995) offered insightful knowledge into social conditions which enables cooperation to be developed, resembling recent research conducted in the construction industry in Norway (Skinnarland and Yndesdal, 2010).

Conclusion: The literature shows that Y is related to Z; in that in order to accomplish various types of project outcome, it is vital to address how collaboration may be developed and sustained, and to learn about the barriers to collaboration as well as the social conditions under which collaboration is to take place.

How X is related to Z

Within the construction industry, as in other industries, collaborative efforts, such as partnering and alliancing agreements have been attempted to increase mutual benefits. The increasing use of subcontracts in construction (Shimizu and Cardoso, 2002) demands that project management and other project stakeholders, in working towards their mutual objectives, focus on how to approach the issue of collaboration. However, few studies of the implementation of Last Planner System have explicitly addressed the social aspects of Lean Construction (Coffey, 2000, Andersen et al., 2008).

The literature is limited in terms of explicit indicators of collaboration. Some researchers describe practices and relational effects that indicate some feature of collaboration. Changes in collaborative culture has been linked to an observed change in the

level of conflicts, and problem solving (Jørgensen et al., 2004). According to Reagle (2008), sharing of knowledge and information are key indicators of a collaborative culture. Other authors indicate collaboration in terms of dialogue (Bohm, 1996), communicative action (Habermas, 1991, Slivon et al., 2010), empathy (Preece, 2004) and perspective making and taking (Boland Jr and Tenkasi, 1995, Rommetveit, 1980). Fiedler and Deegan (2007) emphasise the motivational aspects of collaboration.

Studies show divergent results in relation to subcontractors' involvement in progression planning activities (Friblick et al., 2009, Johansen and Porter, 2003, Skinnarland, 2011). Resistance to involvement may be caused by a lack of training (Johansen and Porter, 2003), or the degree of involvement related to the perceived project outcome (Skinnarland, 2011).

Conclusion: The literature shows that X is related to Z; in that various types of joint interaction, alliances, and inter-organisational project groups established to achieve various types of project outcome, also suggest that collaboration has improved, as an implicit result.

The literature review shows that X is related to Y, and that Y is related to Z. Although much of the research referred to have not had as a primary objective to relate joint activities directly to improved collaborative relationships, research demonstrate that working in partnerships, alliances and on temporary projects to achieve a common goal, may also influence the collaborative culture. Thus X may be suggested to be related to Z.

The synthesised outcome of the literature suggests that X, Y and Z are related to each other. Progression planning tools, such as the Last Planner System, has been introduced as a methodology to involve more participants in planning of the project, and as such, may represent X as a tool for joint interaction. Research on the use of project management progression planning tools in developing a collaborative main contractor subcontractor relationship is scarce, and thus represents a gap in the literature in the field of construction management. This conclusion supports the investigation of the proposed title of the research programme "Use of Progression Planning Tools in Developing Collaborative Main Contractor – Subcontractor Relationships in Norway". Current research aimed to go beyond relatedness in terms of inferring causal links.

The six sets of indicators proposed in the research programme were related to degrees of familiarity and common goal setting, involvement and communications, conflict and trust, motivation, awareness of each other's perspectives and predictable work-

ing processes. Although no research was found that explicitly used these indicators, the literature collectively supported the use of the six groups of variable indicators proposed. However, the limited explicit use of indicators also necessitated a pilot study to be conducted, that included all indicators extracted from the literature, and analysed these statistically to reduce the number of indicators that were used in the main study.

The limited research on the proposed issue also necessitated a pilot study to investigate whether the proposed research programme and methodology was suitable, valid and reliable, in terms of investigating the relationship.

3.3 Pilot study report

3.3.1 Introduction

Limited research exists on the use of project management collaborative progression planning tools, in developing collaboration among participants of temporary projects, where several companies contribute with subcontracted man-hour input into the construction of unique and custom-designed products. A pilot study was therefore conducted to test the feasibility of the research methodology proposed in the research programme.

The objectives of the pilot study

The research programme was designed to address the research question from two perspectives; one was whether there were functional relationships between the use of collaborative progression planning tools and improved collaborative relationships between the main contractor and subcontractors; the other was to find out *how* progression planning tools may be employed to positively influence this relationship.

3.3.2 Methodology

The proposed research design suggested that the pilot study should contain both a quantitative and a qualitative approach to data collection. In the qualitative element of the study, a case study (Yin, 1984) approach with interviews and observation in progression planning meetings were conducted.

For the quantitative element a survey questionnaire was developed, with the objective to establish a set of concise variables, as indicators of collaboration, to be used in the main study.

Selection of pilot study sample and data collection process

Two construction projects, within two different construction companies, were selected for the pilot study. They were both selected qualitatively using a non-probability, purposeful sampling method. The underlying principle for this selection approach was the need to select information rich cases (Patton, 1994). Both projects implemented collaborative planning methodologies based on the Last Planner System (see chapter 2.4, on page 46). Interviews were conducted with 32 people, from main contractors and subcontractors. Transcripts were made and later analysed.

For the quantitative study four construction projects were selected, two from each of the noted construction companies. Based on the research design proposed, the sample was again specifically and qualitatively selected (Patton, 1994) rather than randomly drawn from a large population, on the same basis as noted above. The selection criterion again was that the projects were implementing collaborative planning methodologies.

Response rate

The population was considered to consist of all workers and managers present on the building site, on a specific day, and in a specific time period. A total of 120 people were approached with an invitation to answer the questionnaire. 10 declined, and 110 respondents returned the questionnaire. This gives a response rate of 91,7 percent. The 10 people that declined based their decision either on language barriers, or recent entry into the project (less than a week prior to the survey).

Enquiry about the questionnaire

In the process of collecting responses to the survey questionnaires, a randomly selected sample of approximately 20 percent of the respondents were approached and invited to comment on different aspects of the questionnaire in terms of length of time needed to answer, use of language and concepts, etc. Comments were made concerning relevance, foreign workers and language barriers, language simplicity and similarity, and a mix of concepts.

3.3.3 Data analysis

The qualitative data gathered was analysed using thematic analysis (Fereday and Muir-Cochrane, 2008). In establishing themes when analysing the transcribed data, comparison was a dominant principle. Comparison is a purposeful approach to systematise data from interviews (Boeije, 2002), which enables theory development inductively by con-

necting categories of data. Boeije (2002) and her colleagues developed a procedure for this technique starting with internal comparison within a single interview, and later comparisons between interviews in one group and comparisons within groups of interviews. No software program was applied in this process.

The main objective of the data analysis was to test whether the semi-structured questions were understood in terms of language and concepts used. The observation protocol captured expected behaviour, and was regarded a useful tool for the main study.

The quantitative data was analysed using SPSS 15.0 (Statistical Package for the Social Sciences). The main objective was to analyse variables to reduce the number of indicators of collaboration to be used in the main study.

Reducing the number of variables

Cronbach's Alpha (CA) was used to test the internal consistency (reliability) within the set of variables. CA tests whether a set of items are consistent with one another, to such a degree that they can be combined in a single scale reference (Berglund, 2004). This approach to testing variable consistency and to produce a final set of indicators has been performed in previous research both in international business studies, e.g. on testing variables which influence multinationals' foreign entry mode choices (Kim and Hwang, 1992), and more frequent, in health care research, e.g. (Engels et al., 2006).

The purpose was to create a new index which may be valuable in providing a summary and reflect a large number of variables.

3.3.4 Findings/results

Based on the indicative pilot study findings, the suggested triangulation of qualitative and quantitative data collection methods was employed in the main study, subsequent to minor changes suggested in the full pilot study report included in appendix B, on page 217. The findings suggested that the proposed triangulation for the main study was suitable to address the research question in terms of functional relationships between the use of collaborative progression planning tools and improved collaborative relationships, and in terms of exploring *how* progression planning tools may be employed to positively influence this relationship.

3.4 Pilot study summary

The pilot study contained both a qualitative and a quantitative approach with the main objective to test whether the methodological design was appropriate to address the research question proposed. The qualitative analyses showed that a triangulation of methods, such as interviews and observation, was suitable to extract data on how the use of project management progression planning tools may affect collaborative relationships.

A main objective in the pilot study was to reduce the number of indicators of collaboration extracted from the literature and from previous research by the candidate. Both a quantitative and qualitative approach was applied. The qualitative approach contained a thematic grouping of the 15 variables. Later the groups were tested for internal consistency with the use of Cronbach's Alpha. The 15 variables, or indicators, obtained from this process, were as follows:

Collaborative planning...

1. ... contributes to contractors working as one team
2. ... influences contractors to increasingly work towards a common goal
3. ... contributes to closer dialogue between contractors
4. ... enables me to be more involved in the construction process
5. ... helps us to jointly solve problems at an early stage
6. ... contributes to fewer conflicts and blaming/criticism among contractors
7. ... contributes to increased job satisfaction
8. ... makes me commit to take more responsibility in the project
9. ... makes me more interested other trades' work processes
10. ... positively affects contractors to offer a helping hand and to share resources
11. ... positively affects the perceived equality among contractors
12. ... gives me greater confidence that promises made by other trades are kept
13. ... contributes to more structured meetings
14. ... contributes to a tidier and more organised site
15. ... makes me focus more on improvement and learning

These 15 indicators may be sorted under the set of six indicators presented in section 3.6.1, on page 64.

3.5 Synthesis of the pilot study outcomes and the literature synthesis

The synthesised outcome of the literature suggests that research on the use of progression planning tools, in developing collaboration in the main contractor subcontractor relationship, is scarce, and thus represents a gap in the literature in the field of construction management. This conclusion supports the investigation of the proposed title of the research programme "Use of Progression Planning Tools in Developing Collaborative Main Contractor – Subcontractor Relationships in Norway".

The six sets of indicators proposed in the research programme were related to degrees of familiarity and common goal setting, involvement and communications, conflict and trust, motivation, awareness of each other's perspectives and predictable working processes. Although no research was found that explicitly used these indicators, the literature collectively supported the use of the six groups of variable indicators proposed. The limited explicit use of indicators found in the literature necessitated a pilot study to be conducted. The pilot study included all indicators extracted from the literature, and statistical analysis was applied to reduce the number of indicators to be used in the main study. The limited research on the proposed issue also necessitated a pilot study to investigate whether the proposed research programme and methodology was suitable, valid and reliable, in terms of investigating the relationship.

The analysis of the quantitative survey in general proved to be a suitable instrument to test the functional relationship between use of progression planning tools and development of a collaborative culture. Flaws detected were corrected in the main study. The second main objective in the pilot study was to reduce the number of indicators of collaboration extracted from the literature. 15 variables, or indicators, were obtained from this process.

Based on the above synthesis of the literature review and the pilot study, the basic theory was advanced into a formal theory which was tested empirically in the main study. This was based on the grounds that the pilot study results and the literature review synthesis supported the proposed need to explore the research question.

3.6 Formal theory

The literature review synthesis and the pilot study report suggested that the basic theory developed from the literature synthesis should advance into a formal theory to be tested in the main study. In the following sections the formal theory will be presented stating

the research questions, research aims and objectives, research hypotheses along with the corresponding operational hypotheses.

3.6.1 Research questions

The main research question in this thesis is

Can collaborative progression planning tools be used to increase the degree of collaboration in construction projects in Norway?

The underlying research questions address the three perspectives shown in section 3.2. The research question addressed in part I is explorative in form

"Can collaborative progression planning tools be used to improve project delivery in construction projects in Norway?"

In part II, a similar explorative approach was taken to answer the question

"How can collaborative progression planning tools be used to increase the degree of collaboration in construction projects in Norway?"

In part III the research hypothesis raised statistically answered the main research question

"Can collaborative progression planning tools be used to increase the degree of collaboration in construction projects in Norway?"

For the reminder of the thesis, the six set of indicators chosen to explore a development of collaboration in this research are referred to as collaborative dimensions. These are:

1. Degree of familiarity and common goal setting
2. Degree of involvement and communications
3. Degree of conflict (trust)
4. Degree of motivation
5. Degree of awareness of each other's perspectives
6. Degree of predictable working processes

3.6.2 Research aims and objectives

Research aim

To test if there is a positive functional relationship between the use of progression planning tools and the degree of collaboration in construction projects.

Research objectives

1. To test if there is a positive functional relationship between the use of progression planning tools and the degree of familiarity and common goal setting in the construction project.

2. To test if there is a positive functional relationship between the use of progression planning tools and the degree of involvement and communications in the construction project.

3. To test if there is a negative functional relationship between the use of progression planning tools and the degree of conflict in the construction project.

4. To test if there is a positive functional relationship between the use of progression planning tools and the degree of motivation in the construction project.

5. To test if there is a positive functional relationship between use of progression planning tools and the degree of awareness of each other's perspectives in the construction project.

6. To test if there is a positive functional relationship between use of progression planning tools and the degree of predictable working processes in the construction project.

3.6.3 Research hypotheses

Objective 1

H0

There is no positive functional relationship between the use of progression planning tools and the degree of familiarity and common goal setting in the construction project.

H1

There is a positive functional relationship between the use of progression planning tools and the degree of familiarity and common goal setting in the construction project.

Objective 2

H0

There is no positive functional relationship between the use of progression planning tools and the degree of involvement and communications in the construction project.

H1

There is a positive functional relationship between the use of progression planning tools and the degree of involvement and communications in the construction project.

Objective 3

H0

There is no negative functional relationship between the use of progression planning tools and the degree of conflict in the construction project.

H1

There is a negative functional relationship between the use of progression planning tools and the degree of conflict in the construction project.

Objective 4

H0

There is no positive functional relationship between the use of progression planning tools and the degree of motivation in the construction project.

H1

There is a positive functional relationship between the use of progression planning tools and the degree of motivation in the construction project.

Objective 5

H0

There is no positive functional relationship between the use of progression planning tools and the degree of awareness of each other's perspectives in the construction project.

H1

There is a positive functional relationship between the use of progression planning tools and the degree of awareness of each other's perspectives in the construction project.

Objective 6

H0

There is no positive functional relationship between the use of progression planning tools and the degree of predictable working processes in the construction project.

H1

There is a positive functional relationship between the use of progression planning tools and the degree of predictable working processes in the construction project.

3.6.4 Operational hypotheses

H0: As the use of progression planning tools increases the degree of familiarity and common goal setting in the construction project does not increase.

H0: As the use of progression planning tools increases the degree of involvement and communications in the construction project does not increase.

H0: As the use of progression planning tools increases the degree of conflict in the construction project does not decrease.

H0: As the use of progression planning tools increases the degree of motivation in the construction project does not increase.

H0: As the use of progression planning tools increases the degree of awareness of each other's perspectives in the construction project does not increase.

H0: As the use of progression planning tools increases the degree of predictable working processes in the construction project does not increase.

Corresponding alternative hypotheses

H1: As the use of progression planning tools increases the degree of familiarity and common goal setting in the construction project increases.

H1: As the use of progression planning tools increases the degree of involvement and communications in the construction project increases.

H1: As the use of progression planning tools increases the degree of conflict in the construction project decreases.

H1: As the use of progression planning tools increases the degree of motivation in the construction project increases.

H1: As the use of progression planning tools increases the degree of awareness of each other's perspectives in the construction project increases.

H1: As the use of progression planning tools increases the degree of predictable working processes in the construction project increases.

Chapter 4 Research methodology development

4.1 Introduction

Chapter 3 synthesised the literature review and proposed an X-Y-Z model to examine the relationships between collaborative practices (X), project outcome (Y) and impact on collaboration (Z). The research design for the main study was built on this model to examine the following:

I. The literature shows that X is related to Y; in that various types of joint interaction, alliances, and inter-organisational project groups have been established in order to achieve various types of project outcome; such as increased productivity performance, or other performance measures and goal attainment.

II. The literature shows that Y is related to Z; in that in order to accomplish various types of project outcome, it is vital to address how collaboration may be developed and sustained, and to learn about the barriers to collaboration as well as the social conditions under which collaboration is to take place.

III. The literature shows that X is related to Z; in that various types of joint interaction, alliances, and inter-organisational project groups that were established to achieve various types of project outcome, also suggest that collaboration has improved, as an implicit result.

4.2 Research strategy and design

The research strategy was dominantly empirically based research, although theoretical assumptions made from a thorough study of the relevant literature in the field of organisational culture and construction management, provided necessary understanding and direction. The empirical data was generated from a combination of research methods

addressing the research questions raised in chapter 3.6.1, on page 64. The research strategy was to address the research questions using different methodological research approaches.

4.3 Research methodology

The research methodology proposed was a combination of case study and survey. In addressing point I, above, a case study of project managers and foremen's experienced project outcome and usefulness, was conducted. The aim was to test conclusion nr I from the literature review synthesis, that X is related to Y.

In addressing point II, a longitudinal case study was employed based on two construction projects, over a period of ten months. The aim was to explore collaborative progression planning processes within these two projects, and to understand and explain the collaborative processes taking place.

In addressing point III, a survey among construction project participants was employed to study effects on collaboration of the use of collaborative progression planning. The aim was to test statistically whether there were functional relationships between the use of progression planning tools and the development of collaborative main contractor subcontractor relationships in Norway. In summary, the perspectives addressed above suggested that research was carried out in three separate parts, from which results are discussed and summarised in chapter 6.

Part I How X is related to Y

Literature suggested that various types of collaborative activities had been established to achieve various types of project delivery outcome, such as increased productivity performance, or other performance measures and goal attainment. Although this relationship may be peripheral to the main scope of this research (the Y-Z relationship), this relationship was tested explicitly within the construction project level in this research. A case study of project managers' and foremen's experienced project outcomes and usefulness, was conducted. Focus group interviews (see interview guide in appendix C, on page 231) were conducted with 34 key informants in groups of up to six respondents, besides two individually. Except from one group interview with a foreman and a project manager, interviews were conducted with groups of foremen and managers respectively. The purpose of this arrangement was to stimulate interactivity within a group on the same management level, assuming informants then would share similar experiences and

challenges, thus being more motivated to express their opinions openly, than could be the case in a mixed group. The interactive group setting also demanded that the researcher stimulated an equal balance of responses, to prevent group bias and dominant individuals. The aim of the interviews was to map a) respondents' experiences with project delivery in terms of measurable effects (time, budget, quality, etc.) in projects having used collaborative planning methodologies and b) qualitative statements concerning the felt usefulness of the methodology in delivering the project.

Respondents in this study represented a number of projects within a large Norwegian construction company. The interview guides were not pilot tested in the field, but were extensively discussed with field experts.

Part II How Y is related to Z

Literature suggested that it is vital to address how collaboration may be developed and sustained, and to learn about barriers to collaboration as well as the social conditions under which collaboration is to take place. The longitudinal case study proposed to address this relationship was one of two perspectives taken to study the relationship between the use of progression planning tools and the main contractor subcontractor collaborative relationship. While the proposed survey set out to establish statistical functional relationships between such use and collaboration, the case study approach aimed to explore *how* collaborative progression planning processes may help develop collaboration. The case study was based on two construction projects which were followed over a period of ten months.

Part III How X is related to Z

Literature suggested that various types of joint interaction, such as the use of collaborative planning methodology, had indirectly resulted in improved collaboration within the construction industry. A survey was therefore proposed among construction project participants to study effects on collaboration of collaborative progression planning activities. The aim was to test statistically whether there were functional relationships between the use of progression planning tools and the development of collaborative main contractor subcontractor relationships in Norway.

Respondents in the survey comprised participants in 12 construction projects within two construction companies in Norway. The pilot study predicted a response rate of 410 respondents, while 485 were in fact obtained. Participants were comprised of project management, middle management, team supervisors, skilled and unskilled workers and apprentices. The projects selected for the survey were all employing the collabora-

tive progression planning tools described earlier. However, the level of collaborative progression planning activities was expected to vary according to the needs of the projects.

A self-administered questionnaire was developed and tested in a pilot study. A main objective of the pilot study was to statistically reduce a list of indicators of collaboration for the main study. The refined questionnaire consisted of three main sections; a) background information; b) participation in activity related to collaborative progression planning; and c) experiences of collaborative effects. Background information asked for in section a) referred to age, gender, position in the project, seniority, formal education etc. In section b) a set of activities had been pre-defined as activities related to collaborative progression planning. The defined list of activities was based on previous research by the author in the same construction companies. In section c) respondents were asked to rate 15 statements (based on indicators) about collaboration on a five-point scale (Likert, 1932). Five-point rating scales on attitudes has previously been used also in research concerning construction projects (Chan et al., 2004). The statements were produced post pilot study (see appendix D for questionnaire design).

The survey took place between March and September 2012. Data collection was organised as researcher visits to the building sites, with an invitation to all workers and management present to fill out the survey questionnaire during lunch break. Although this method entailed high costs, priority was still given to increase response rate.

Survey data was inserted into and analysed using SPSS. Standard analysis techniques such as the Chi-square test and regression analysis were applied to test whether there was a relationship between the variables.

In the following sections the use of case studies with associated methods in this research is explained.

4.4 Case studies

Development of theory is a central activity in organisational research. Traditionally authors have developed theory by combining observations from previous literature, common sense, and experience. However, the tie to actual data has often been tenuous (Perrow, 1986). Glaser and Strauss (1968) hold that the intimate connection with empirical reality permits the development of testable, relevant, and valid theory.

The case study approach, although a challenging social science endeavour, is a common way of doing research (Yin, 1994). Flyvbjerg (2006) states that case studies provide a systematic way of looking at events, collecting data, analysing information, and reporting the results. Feagin, Orum, & Sjoberg (1991) consider case studies to be an ideal methodology when a holistic, in-depth investigation is needed.

There have been some valuable sources of information and guidance for case study methodologies (Hamel et al., 1993). Stake (1995) and Yin (1984, 1994), in particular, have provided specific guidelines for the development of the design and execution of a case study. Method and analysis should occur simultaneously in case study research. Specifically, data collection and analysis should occur as an iterative process, wherein the researcher moves between the literature and field data and back to the literature again. Yin (1994) offers a very straightforward protocol approach for case study, emphasising field procedures, case study questions, and a guide for the final write up. Yin claims such steps are a major tactic in increasing the reliability of the research endeavour. Similarly, Stake (1995) has proposed a series of necessary steps for completing the case method, including posing research questions, gathering data, data analysis and interpretation.

Researchers may gain a sharpened understanding of why the instance happened as it did, and what might become important to look at more extensively in future research. Case studies lend themselves to both generating and testing hypotheses (Flyvbjerg, 2006). Following this argumentation for case studies, it seems that a case study is an appropriate research methodology in addressing the process of developing collaboration in construction projects. Case studies are designed to bring out the details from the viewpoint of the participants, by using multiple sources of data, hence the multi-case application of two projects in Part II, and respondents representing several projects in Part I. Following the iterative process suggested by Hamel et al., (1993), Stake (1995), and Yin (1984, 1994), a pilot project was also conducted.

Yin (1994) suggested using multiple sources of evidence as the way to ensure construct validity. In Part II, interviews with project participants were combined with observation in collaborative progression planning meetings in two construction projects from two different companies, thus meeting the ethical need to confirm validity.

The background reading of Lean Construction literature revealed that several case-studies had been conducted relating to implementing new approaches to planning in the construction industry (Conte, 1998, Auada et al., 1998, Johansen and Porter, 2003, Kim

and Jang, 2005, Friblick et al., 2009), thus this research methodology seemed appropriate to this research.

4.4.1 Case study research methods

The research methods employed in this research were qualitative methods based on in-depth interviews, focus groups, observation and document study.

Interviews

In part I, semi-structured interviews were conducted with 34 project managers and foremen. The purpose was to map experienced project outcome and usefulness of the progression planning methodology.

In part II, semi-structured in-depth interviews were conducted with project managers, foremen, supervisors and trade workers in the projects, both from the main contractor and subcontractors. The purpose of the interviews was to study the collaborative planning processes to gain understanding of how collaboration between main contractors and subcontractors may develop. A list of informants (roles) in Part II is enclosed in appendix A3, tables 3 and 4.

Semi-structured interviews were conducted as this approach allowed new questions to emerge from interviewee information. Previous research in this field conducted in-depth interviews as a form of information gathering in similar projects (Friblick et al., 2009, Alsehaimi et al., 2009). A framework of themes was explored, (see interview guide in appendix D, on page 233). The case-studies referred to above (Friblick et al., 2009) did not indicate what kind of questions that have been asked. Interview guides were therefore based on previous research on Last Planner System implementation processes in Norway (Skinnarland and Moen, 2010), and tested in a pilot study. For Part I, the interview guide was tested in a focus group with experts in the field.

In part I, interviews were conducted at the company headquarter. In part II the interviews were conducted on the building sites, as this arrangement caused fewer disturbances and inconvenience to the informants. The individual interviews lasted for one hour and the focus group interviews for approximately one and a half hours, up to two hours. Since some trades were on the site in the beginning of the project period, others in the middle, and still others towards the end, the interviews were conducted at several points in time during the ten month field-work. Interviews with project managers were conducted on several occasions and the remaining individual informants once. Based on a similar case study, the number of interviews seemed adequate (Friblick et al.,

2009). Focus groups were conducted twice based on the same reasoning as for individual interviews.

In sum for the two construction projects in the case study (Part II), a total of 51 informants took part in the interview scheme.

For comparison and verification, case-studies concerned with implementation of Lean Construction principles in previous literature often lacked detail in terms of methodology used, number of interview informants, as well as respondent characteristics.

Focus group

Focus group as a research method has been in use since the 1940s. Focus group discussions may reflect internal group processes and can be used to generate information on collective views (Bloor, 2001), here on the effects of collaborate progression planning. Focus groups may yield data on the underlying factors that explain the experienced effects. As a research method, focus groups are often used to compliment other methods, for example as an extension of other methods. Focus groups may be valuable as a supplement to in-depth interviews to generate contextual data such as illustrative stories. This research method is also an economical alternative to generate data on group processes. Research participants from a pre-existing group, as trade workers participating in the same construction project, may communicate valuable comments about shared experiences and effects, and generally promote discussion and debate (Kitzinger, 1994).

Observation

In addition to in-depth interviews and focus groups, planning meetings were observed on several different points in time during the field-work period. Planning meetings related to the collaborative planning methodology adopted in the construction projects were executed at two different managerial levels. Both levels were observed. The aim of the observation was to study how the participants behaved in terms of involvement, engagement, discussion etc., as well as how management encouraged collaboration. Observations focused on expressed willingness to commit to planned progression, and on the level of communication. The progression planning meetings were assumed to constitute an arena for team-building and a development of a sense of familiarity; hence observation looked for evidence of such behaviour. Observing in meetings was assumed a valuable addition to interviews as they could prove or disprove a manifestation of what the informants themselves understood about ongoing processes.

Document-study

In part II a document-study was conducted including project level strategic documents, project objectives, posters etc. that could inform the research.

4.5 Regression analysis

Data were inserted into SPSS for analysis. Processing and analysis of data was performed in several steps.

Step 1 Initial descriptive data analysis

The first step after inserting the data into SPSS was to produce descriptive statistics such as frequencies of all variables. The output was analysed with two objectives in mind. Objective one was to use descriptive statistics output to check the data set for errors. Identified errors were corrected accordingly. The second objective was to perform initial analysis.

Step 2 Prepare data set for analysis

The second step of the analysis process was to recode independent and dependent variables.

Dependent variables

The dependent variables were constructed based on the six dimensions of collaboration extracted from the literature review and pilot study tests. In the survey questionnaire, the six dimensions were operationalised into a set of 15 statements, or factors (based on pilot stage analysis). A re-confirming factor analysis test was performed to establish six indices (see also page 147) (dependent variables):

1. Degree of familiarity and common goal setting
    A. contributes to contractors working as one team
    B. influences contractors to increasingly work towards a common goal

2. Degree of involvement and communications
    A. contributes to closer dialogue between contractors
    B. enables me to be more involved in the construction process

3. Degree of conflict (trust)
    A. helps us to jointly solve problems at an early stage
    B. contributes to fewer conflicts and blaming/criticism among contractors

4. Degree of motivation
    A. contributes to increased job satisfaction
    B. makes me commit to take more responsibility in the project
    C. makes me focus more on improvement and learning

5. Degree of awareness of each other's perspectives
    A. makes me more interested in other trades' work processes
    B. positively affects contractors to offer a helping hand and to share resources
    C. positively affects the perceived equality among contractors

6. Degree of predictable working processes
    A. gives me greater confidence that promises made by other trades are kept
    B. contributes to more structured meetings
    C. contributes to a tidier and more organised site

Independent variables

Two sets of independent variables were established that could affect the dependent variables mention above.

The first sets of variables were individual demographic background variables such as a) age, b) position, c) formal education, d) years with current employer, and e) previous experience with collaborative planning methodologies. Other background variables were f) project affiliation (main contractor or subcontractor), and g) construction company size. The main arguments for including the above background variables were, firstly, a theoretical interest in knowing who the respondents were and how they differed in terms of age, position, education etc. Secondly, and a more important argument to this research, was the need to control for background variables to ascertain that the essential independent variables; participation in collaborative planning activities, in fact had the effects that were to be studied. For instance, did participation in weekly planning meetings have an effect by itself, or was the effect mainly a result of age and education?

Also, within the set of background variables, it was interesting to look for variations between positions (do managers give higher scores than workers?), as well as variations according to age, formal education, company affiliation, etc. Although such findings may not contribute directly to knowledge about the effect of use of collaborative planning tools on developing relationships, findings may point to managerial implications, and constitute theoretically interesting starting points for future research.

The second set of independent variables established, were variables conceivably related to collaborative planning structure, routines and relations. These variables were subdivided into a) participation in developing plans, b) attending meetings where facilitation of production was central, c) shared facilities, and d) perceived appreciation by project participants.

Recoding independent variables

Independent background variables were recoded into categories and reference categories established (category to which all other categories are compared). Recoding variables entails a risk of losing information, however, data needed to be recoded to enable multiple linear regression analysis to be carried out. It was assumed that recoding of variables did not impair the value of the analysis.

The categories were then recoded into dummy independent variables (variables with the value 0 or 1) to prepare for regression model analysis. Dummy variables are numerical representation of nominal or ordinal variable categories. Some variables were recoded into a number of separate, dichotomous variables, such as position and formal education.

Replacing missing values

An option when handling missing values is to omit those cases and conduct analysis based on remaining cases. In this research, however, missing values in the dependent variables were replaced by values calculated as the mean of values on the individual level (x 0.50) + the mean of values on the group level (x 0.50) (Christophersen, 2006). The replacement of missing values introduces some possible bias into the model for that variable. However, non-missing values may still contribute to the regression model, thus providing strength in terms of a higher number of cases (*n*). A precondition to calculate missing values with mean scores is that more than 50 percent of values remain on both individual and group level. In current research, levels of missing were well within

those requirements. In addition, a qualitative assessment of the data affirmed that missing values did not form any pattern and seemed random.

Tests were performed to check for errors in recoding into categories, into dummy variables, and in handling of missing values. A substantial qualitative checking of the data set was carried out in addition to cross tabulations of old and new category variables to check for errors.

Step 3 analyses with multiple linear regression models

In step 3 of the analysis process, dependent and independent variables were inserted into multiple linear regression models.

Requirements for regression analysis

Multiple linear regression was a suitable statistical method to analyse current data since the objective was to examine the extent to which the distribution of a dependent variable could be explained by one or more independent variables.

There are certain assumptions that need to hold true to use regression analysis. The sample generally needs to be randomly and independently selected. In this research, random selection was partly met by establishing selection criteria upon which the 12 projects were selected. The criterion of random selection was further attempted to be obtained by the selection of a particular day for the visit. Although the date was known, selecting a different day in the course of the project may have resulted in a different composition of respondents.

Data have to be normally distributed. In this research n was considerably larger than 30 and the Central limit theorem (CLT) imply that as long as the sample size is larger than 30 the sampling distribution will be normally distributed.

Assumptions about residuals need to hold. Analysis of the residuals consists of several components. First the residuals need to be normally distributed. With the large n it may again be assumed that residuals are normally distributed, based on the central limit theorem. Also, histograms and probability plots may be investigated to conclude about the assumption.

Residuals need to be independent. However, as the test was static, independence was assumed. Last, any homoscedastic behaviour needs to be investigated to check randomness and patterns. An R square close to zero suggests no pattern, and thus the homoscedasticity assumption is not violated. Any outliers must be checked. If within +-three standard deviations assumptions are met.

Variables in this research were categorical. Some variables were transferred into categorical variables by using binary categories, i.e. dummy variables.

Limitations to the data set

There were limitations to the data set in terms of both sample selection and data collection.

Sample selection

Since the survey objective was to investigate the relationship between the use of progression planning tools and developing a collaborative relationship, cases needed to be selected that used the collaborative planning methodology to some extent. Thus, a random selection of construction projects within Norway was not an option. A further criterion was that project management had to give consent to the survey. The selection may be biased on the grounds that project managers that did not find the methodology to work in their projects simply refused to consent to participate, leaving more successful projects to be included in the data.

Data collection limitation

The researcher was present on all 12 construction sites, and approached potential respondents with a request to participate in the survey. Upon request, the respondents were informed that the test would take approximately 10 minutes to answer. Respondents were sitting in groups around large tables in the lunch facilities. Sitting close to other respondents (colleagues) may have entailed possible bias, since, if uncertain how to score a statement, they could copy the answer of their neighbouring respondent. It was assumed that researcher presence had a dampening effect on copying behaviour.

At the same time, the presence of the researcher may have influenced respondents to answer more positively than they otherwise would have done. Although respondents were informed that the researcher would be available to clarify questions, a distance to the respondents was attempted to prevent a perception of being monitored.

Survey questionnaires may be biased on the grounds that respondents choose not to tell their true opinions, or they get tired or bored and make systematic answers rather than qualified answers. Respondents may also make selective non-responses to any number of questions. These forms of bias may be present in any survey, however, it was assumed that location and collection procedures did not stimulate such bias to occur, but rather prevented it.

One criterion was to approach all potential respondents on a specific day (informed in advance), in the lunch break, in the shared lunch facilities. Such a situation may potentially cause a bias in collection of data, as respondents who did not want to participate, for whatever reason, simply could refrain from showing up at lunch break. Even if an estimate of project participants present on the day of the visit could theoretically be provided by project management, the difference between expected and actual potential respondents could not have been explained as refusal to participate in the survey alone. Although potential respondents would have participated, they could have spent their lunch break elsewhere (some had their lunch break in own cars or containers) on the construction site, or run necessary errands on that particular day.

Data collection was conducted honestly and respectfully towards the respondents and towards EBS regulations. Data was collected ethically (no harm to responders, physically or psychologically) and truthfully, i.e. was not manipulated or altered. Data was secured and stored safely in a responsible manner, as was the use and portrayal of data.

4.6 Research analyses

All individual and focus group interviews were taped and transcribed for later analysis. Qualitative, reflective types of analysis (Argyris and Schon, 1974) were employed. There was an ongoing analysis process throughout the data collection period where the researcher thought about and reflected upon emerging themes. Although a predeveloped interview guide was used, it was vital to adapt to unforeseen events and to develop guides accordingly. For instance, if early interviews raise new issues, the interview-guide was refined to include the emerged issues for the upcoming interviews. In combination with the reflective analysis, an approach to analysing qualitative data was to adopt thematic analysis (Fereday and Muir-Cochrane, 2008). Inductive analysis was proposed in this research, and themes emerged from the data as well as being imposed upon by the researcher. Thus, data collection and analysis took place concurrently.

4.7 Triangulation, reliability and validity

The purpose of triangulation with different methods was to increase validity of research findings. Therefore several methods were combined to collect data. This reasoning is

in line with Denzin (2006). Cohen et al. (2000) define triangulation as studying human behaviour from two or more perspectives to give a broader explanation of the complexity of human behaviour. Recent research into construction project processes has emphasised the vital role of triangulation to collect valid data (Friblick et al., 2009, Alsehaimi et al., 2009).

Reliability and validity concerns were considered throughout the research. The research was based on studies in two different construction companies, and several construction projects, which improved reliability of the data as data from only one could be too company specific. Although the case study was not carried out as a comparative study, choosing cases from two different companies offered more variation in terms of project settings and frameworks which proved valuable to the outcome of the research. The use of a pilot-study, a multi-project approach in the main study, together with a triangulation of methods employed, contributed to improve reliability and validity of the research.

4.8 Summary

Three separate research elements were included in this study to answer the main research question posed; *"Can project management's collaborative progression planning tools be used to increase the degree of collaboration in construction projects in Norway?"* The research design was couched around three main relationships expressed in an X-Y-Z relationship model. The research methods chosen were case studies and a quantitative survey.

Chapter 5 Data collection and analysis section

5.1 Introduction

This chapter gives a detailed account of the data collection and analysis. Current research was separated into three parts, with different perspectives in studying the relationship between use of progression planning tools and contractor relationships. In the following sections, each part of the study will be accounted for in terms of data collection and analysis.

5.2 Part I

5.2.1 Introduction Part I

A study was conducted in October and November 2011, to explore the experiences of Norwegian project managers and foremen while using collaborative planning, based on the Last Planner System as a systematic framework for planning purposes. The company, from which data was collected, has since 2008 implemented LPS in many of their projects. This entails that employees and subcontractors to a greater extent than in previous projects have been involved in the progression planning process of the projects. Top management wanted to find out whether implementing LPS was beneficial to them. The perspective taken was to study effects and outcomes experienced among project managers and foremen, from implementing LPS, to learn more about company projects' use of LPS and eventual benefits.

About the construction projects

Part I research was based on data from 26 unique projects. The duration of these construction projects varied from 1 to 48 months, ranging from short-term rehabilitation work to large scale construction projects. 48 percent were new commercial construction projects. New apartment constructions counted for 28 percent, 11 percent were plant

constructions, whereas 13 percent were rehabilitation projects or other. Essentially, the projects were contracted as turnkey contracts (performing both design and construction), accounting for more than 85 percent of the construction projects.

About the informants

The participants in this study were 54 percent foremen and 46 percent managers, a total of 34 informants, of whom more than 90 percent were men. Nearly half of the informants were 46 years or older. 60 percent had been employed by the company for more than 11 years, and nearly 30 percent had been with the company for 2-5 years. 67 percent of the informants reported from their first project, whereas 30 percent had already completed 1-2 projects with LPS. 13 respondents reported from only one project, 7 respondents reported from two project experiences, 5 respondents reported from three project experiences and one respondent reported from four project experiences. In all, 46 single project experiences were thus captured in the data.

5.2.2 Data collection and analysis Part I

Research questions and hypothesis

The research question addressed in part I was explorative in form, and the aim was to test conclusion number I from the literature review synthesis. Literature showed that various types of joint interaction, alliances and inter-organisational project groups had been established to achieve various types of project outcomes; such as increased productivity performance, or other performance measures and goal attainment. Thus, data was collected and analysed to answer the following question:

"Can collaborative progression planning tools be used to improve project delivery in construction projects in Norway?"

A main hypothesis in Part I of the study was:

The company has benefited from implementing collaborative work practices associated with Lean Construction and the Last Planner System in their projects.

The term Last Planner System was used in Part I research, since more informants in part I were familiar with this term, rather than the term 'collaborative planning'.

The main hypothesis was discussed and analysed in terms of a set of research sub-questions. These were chosen based on previous research into implementation processes (Skinnarland and Moen, 2010, Skinnarland, 2011).

The first set of questions reflects qualitative, non-measurable outcomes and effects that project managers and foremen may have experienced.

1. Is there a relationship between the use of Last Planner System (or collaborative planning) as a collaborative working methodology and project managers' and foremen's experiences with conducting construction projects?

a. May LPS as a collaborative working methodology contribute to a more predictable progress?
b. May LPS as a collaborative working methodology affect employees and subcontractors to take more joint responsibility for project progress?
c. May LPS as a collaborative working methodology contribute to establishing a meeting structure which adapts to different planning levels?
d. May LPS as a collaborative working methodology contribute to conducting analysis of obstacles according to seven preconditions?
e. May LPS as a collaborative working methodology contribute to disseminating the right information to the project organisation?
f. May LPS as a collaborative working methodology contribute to creating arenas for interaction?

The second set of research sub-questions reflects effects that project managers and foremen may achieve on the project level.

2. Is there is a relationship between the use of Last Planner System as a collaborative working methodology and project managers' and foremen's experiences with effects in the form of project delivery?

a. May LPS as a collaborative working methodology contribute to deadlines being kept?
b. May LPS as a collaborative working methodology contribute to projects being delivered within budget?
c. May LPS as a collaborative working methodology contribute to projects being delivered to the specified quality?
d. May LPS as a collaborative working methodology contribute to reduced number of human injuries on the building site?

e. May LPS as a collaborative working methodology contribute to improved levels of job satisfaction?

Data collection

Data was collected by means of focus group interviews and a survey. Structured group interviews with project managers and foremen were conducted in October and November 2011. The interviews lasted from 90 minutes up to a maximum of two hours. Interview consent was secured prior to interviews taking place. The interviews took place at regional or district headquarters, except one that took place on a construction site. The informants were organised in groups of project managers and foremen respectively, except for one interview with a mixed group. One interview was conducted one-on-one. Three interviews were conducted with two informants present, whereas the remaining interviews were conducted in groups of three to six informants. All in all eleven interviews were conducted. Interviews were structured as the main aim was to collect a richness of experiences in terms of a number of pre-set dimensions, as opposed to in-depth knowledge of a limited number of experiences.

In addition, a small survey questionnaire was answered. The objective was to capture quantitatively, informants' opinions concerning pre-set optional answers representing qualitative, non-measurable outcomes and effects experienced. A second objective was to produce an overview of characteristics of projects and informants. The survey was organised within the time frame of the interviews, taking a short break from interviews to answer distributed questionnaires. Informants were asked to respond to 17 statements that could reflect their project experiences. The statements were rated by choosing from 1) no change from previous projects, 2) worse, 3) slightly better, or 4) much better. The interview questions revolved around the 17 statements and other questions, providing both snap-shot answers, and an opportunity to explore issues further. Prior to conducting the interviews the guide was tested in a focus group with field experts.

Limitations of data collection and analysis

As survey data was limited, with only 34 informants, comprised of foremen and project managers, an exploratory data analysis approach (EDA) of the categorical ranked data was used (Saunders et al., 2009 quoting , Tukey, 1977). Using the EDA approach, analysis was attempted by summarising the findings and examining data to explore their relationships. Eisenhardt (1989) warns against drawing hasty conclusions based on limited case study samples. The low sample size thus limits the option of supporting con-

clusions on significance, hence the qualitative approach. Thus, analyses in Part I do not specify actual hypotheses to be significantly tested, rather, the research questions and sub-questions provide the context for discussing the findings.

5.2.3 Findings from interviews and survey

Project experiences in this study were captured by addressing and exploring five main questions:

- What kind of information and support have you received concerning Lean construction/collaborative planning?
- What elements of Lean Construction/LPS have been used in your project?
- Which effects and outcomes have you experienced?
- What was particularly challenging?
- What do you need in order to use the LPS methodology in future projects?

In the following, the above five questions are attended to in separate sections.

Information and support received

When the first two pilot projects started in 2008, there was relatively little information material available concerning Last Planner System (Ballard, 2000) as a planning methodology. Since then, and also based on the two pilot projects, information material was developed within the construction company, and distributed to project managers. Most of the respondents received some information in the form of brief, theoretically-oriented information relevant to the methodology, or orally in meetings, either in regions, districts or projects. Table 5.1 shows to what extent foremen and project managers reported to have received a) no information, b) some information, or c) much information. 9 percent of the informants received no information, 79 percent received some, and 12 percent received much information. Information provided seems to have been distributed evenly among project management and foremen. The interview data indicates that project participants, who entered later in the project, received less information than participants who were involved from the beginning of the construction project.

Informants emphasised that information about Lean Construction specifically aimed at individual projects were more important to them in terms of understanding the methodology, than general theoretical information concerning the methodology. One of the informants expressed this as follows:

"It was better when [nn] was present and we could talk about the specific project, we were a small group and were able to discuss"

	Information Lean construction/LPS			
	Project Management	Foremen	Total	Valid Percent
Nothing	1	2	3	9
Some	13	13	26	79
Much	2	2	4	12
Total			33*	100
	Project support			
	Project Management	Foremen	Total	Valid Percent
Nothing	2	3	5	15
Some	14	11	25	76
Much	0	3	3	9
Total			33	100

Table 5.1. Information and support received in construction projects.

Source: author.

**One of the informants did not answer this particular part of the questionnaire, hence a total of 33.*

In addition to the more general theoretical information about Lean Construction and the Last Planner System, two expert employees were central in knowledge development and adaptation to lean methodology. Both employees supported projects in implementing Lean methodology.

15 percent of the informants received no project support, 76 percent received some support, and 9 percent received much support. 56 percent of those receiving some support were project management, while 44 percent were foremen. However, all informants who perceived having received much support were foremen. Be reminded that this table contains data based on a very low *n*, and thus reliability may be biased.

Conclusion: Overall foremen and project managers received some information concerning Lean Construction/collaborative planning and LPS. The informants also received various types of project support in implementing collaborative planning in their projects. Practical information about LPS and Lean approaches

adapted and related to own projects was perceived to be more important for increasing understanding of the methodology than general and theoretical information.

Use of LPS and Lean Construction principles in projects

In broad terms, lean practices involved the use of kick-off meetings and phase schedule planning; meeting structure adapted to different time horizons; involvement of subcontractors; and planning tools and schemes. Further, use of milestones in planning; planned work zones; and facilities for collaboration were lean approaches noted in the construction projects.

Nearly all projects adopted collaborative phase schedule planning, inviting their own foremen and team supervisors and subcontractors to participate in planning sessions. Progressions planning meetings such as team supervisor meetings and lookahead meetings (Ballard, 1997) were common practices in the projects. Lookahead planning meetings are described in section 2.4.6, on page 46. Although not required or even suggested by the LPS methodology, several projects offered shared office facilities for team supervisors. Team supervisors from the main contractor and from subcontractors were thus offered an arena for dialogue, where they could engage in informal conversations about ongoing daily operations, study and clarify design issues, and generally interact. The access to such facilities was given as an explanation for improvements experienced in the projects. Clarifications among team supervisors released time for foremen and project managers to focus on facilitation of operations in coming weeks.

Conclusion: Elements of Lean Construction/LPS that were utilised in the projects comprised kick-off meetings, often with joint phase schedule planning sessions using post-it-notes, regular meetings adapted to planning horizon, and clarification of which project level role attended the various meetings. Facilities were offered for team supervisors to engage informally and to plan and discuss operations issues.

Experienced effects and outcomes

In this section, experienced effects and outcomes are presented based on interview data and the small survey combined. Table 5.2 shows how project managers and foremen responded in writing to 17 statements concerning experienced effects and outcomes of implementing collaborative practices in their construction projects. In this section each statement is discussed.

	No change		Slightly better		Much better		
	PM	**F**	**PM**	**F**	**PM**	**F**	***n***
Control with progress	5	3	3	11	6	4	*32*
Mutual responsibility	3	4	9	5	2	9	*32*
Meeting structure/planning levels	1	2	9	7	4	8	*31*
Seven preconditions	6	7	6	8	1	2	*30*
Right information	5	3	6	10	3	5	*32*
Arena for collaboration	0	4	7	8	7	6	*32*
Time spent waiting	4	4	6	10	4	4	*32*
Keeping deadlines	4	4	7	9	3	5	*32*
Delivery within budget	6	2	5	7	0	3	*23*
Delivery to right quality	5	8	8	7	2	1	*31*
Few injuries on people	10	7	4	7	0	2	*30*
Few damaged material	11	8	3	6	0	1	*29*
Delivery with few errors	6	2	8	13	1	1	*31*
Well-being on site	3	4	9	5	3	7	*31*
Limited stress	6	4	7	10	2	2	*31*
Limited firefighting	4	4	8	9	2	3	*30*
Tidy workplace	6	6	7	7	2	3	*31*

Table 5.2 Frequencies of qualitative responses to statements.
Source: author.

Table 5.2 shows a low *n*, which demand that care must be taken in terms of statistical analysis. The table further shows that *n* varies along the 17 statements, from 32 to 23. Some informants found it difficult to relate to some of the statements, based on the limited experience with implementing lean practices. Based on the low *n*, a descriptive statistical approach was taken to provide a summary of observations made. This approach is suitable when data is insufficient to conclude about hypotheses based on the data alone. Rather, a percentage score that deviate substantially from 0 suggests a statistical dependency between two variables (Hellevik, 2003).

Figure 5.1 displays a percentage component bar chart (Saunders et al., 2009). The bar chart shows the percentage of informants, project managers and foremen combined, who responded to the statements with 'no change' (blue) and 'change to the better' (red). The category 'Change to the better' comprises the categories 'slightly better' and 'much better'. On average, 69 percent of the informants experienced a change to the better, and 31 percent did not experience any change from previous construction projects where collaborative planning was not used. As shown in figure 5.1, 15 out of the

17 statements are more than 50 percent red, suggesting that the informants to a large extent experienced a change to the better. On two statements; (1) Few damaged material; and (2) Few injuries on people, more than half of the respondents experienced no change.

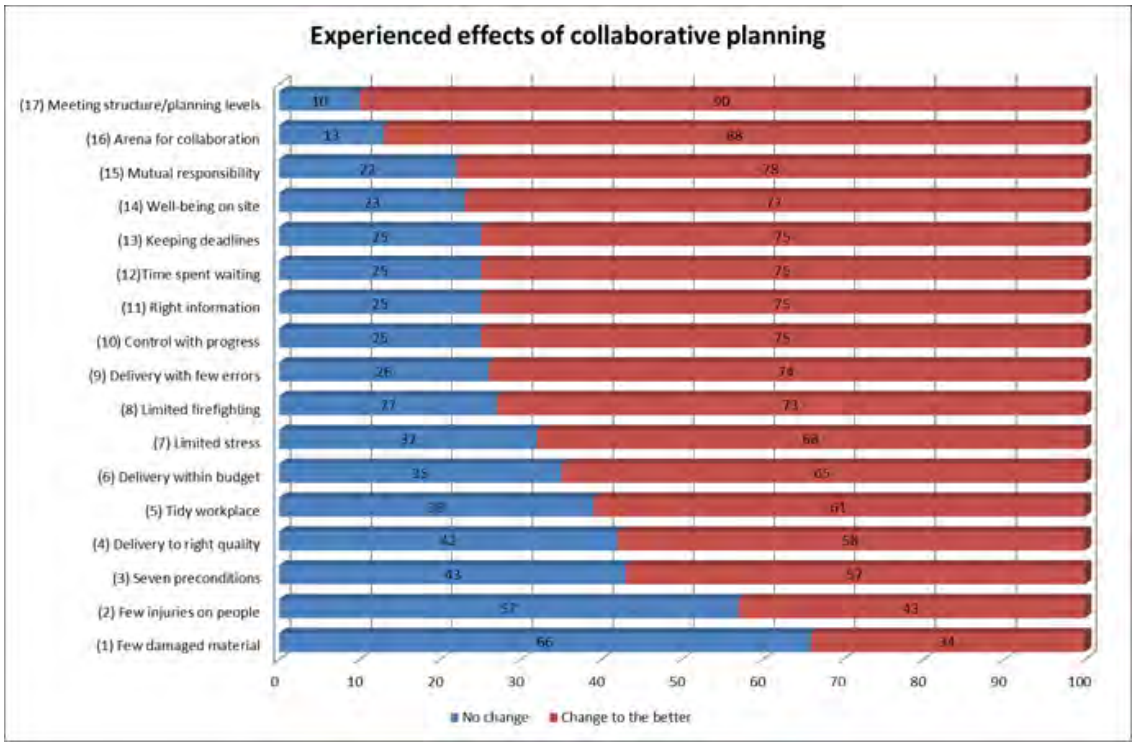

Figure 5.1. Experienced effects of collaborative planning, combined.

Source: author.

The distribution suggests that the informants gave relatively positive responses to (17) Meeting structure/planning levels, (16) Arena for collaboration, (15) Mutual responsibility, and (14) Well-being on site. Each of these is described in the following.

Relational effects and outcomes with high scores

(17) Suggested structures for progression planning meetings were implemented to accommodate specific planning levels. Both project management and foremen had positive experiences in this regard.

> *"Meetings became more structured with lean, and were run on a regular basis. We could deal with issues, rather than just delay making decisions. I found that foremen and supervisors talked and discussed issues more than in previous projects."*

Meeting structures were reported to systematise communication between trades and thus established important arenas for dialogue concerning daily production as well as long-term planning of execution of tasks. Dialogue and joint problem solving was claimed to create a greater degree of commitment and responsibility, which in turn affected the (14) well-being and satisfaction on the site. By involving own employees and subcontractors in phase schedule planning, and later in regular progression planning meetings, a structure was created, which provided arenas for dialogue to obtain correct orders and sequences of activities.

(16) One of the most convincing outcomes from implementing LPS was establishing an arena for collaboration. 88 percent of the informants noted an improvement. This was related to experienced improvement in meeting structures and linking meetings to specific planning levels. In practice, this involved bringing the right people together, on a frequent basis, to discuss and plan for the correct time perspective, and to the appropriate level of detail. Collaboration as such was established in-house among main and subcontractor management.

> *"Supervisors become more aware of what to do next week. They discuss matters in meetings together, face to face, and keep their promises. The supervisor meetings are the best; this is where issues are solved."*

(15) Another effect was increased mutual responsibility among project participants. Foremen seem to have more positive experiences in this respect than project management.

> *"What I feel is the most important thing is that all take responsibility; subcontractors are involved, and take responsibility since they are allowed to participate in planning ahead."*

(14) More than three out of four respondents felt that there had been an improvement in terms of job satisfaction. This result is consistent with qualitative statements in the interviews. Several informants claimed that work had become more rewarding and interesting. LPS was given credit for producing a more open environment, which was partly explained by an overall increase in participants' mutual interest in process knowledge.

"I felt it had to do with people's well-being, they were very happy."

The four top score variables all reflect effects on a relational level. Relational issues were emphasised by the informants in all interviews, as both representing new aspects of conducting projects, and as contributing to positive experiences with implementing collaborative approaches. Thus, figure 5.1 confirms the findings from interview data.

Project delivery outcomes

At the bottom end of figure 5.1, informants still, to a large extent, answered that implementing LPS (collaborative planning) represented a 'change to the better'. However, interestingly, the statements receiving the lowest scores characterise effects more in the form of project delivery effects and outcomes. These were (6) Delivery within budget, (5) Tidy workplace, (4) Delivery to specified quality, (3) Use of seven preconditions, (2) Few injuries to people, and (1) Few damaged material.

(6) When asked about possible improvements to deliveries within budget, nearly 4 in 10 responded that they did not experience any change from earlier, while just over half believed that projects delivered within budget, had improved slightly. However, many responded on the basis of their first and still on-going project, thus their response to this statement was an expression of what they believed might happen, rather than absolute figures. Further, some of the informants chose not to take a position on this question.

(5) A key principle in the Last Planner System is to organise work such that each trade performs its activities in separate, cleared and tidy work zones. Having sufficient place to work is one of seven conditions Bertelsen et al. (2007) refer to as a premise for optimal production flow, and one way of achieving this is by organising/planning work according to zones. Work then may be carried out with less interruption, and hence more efficiently. Related positive effects were increased sense of clarity concerning responsibility for clearing and preparation of work zones, which in turn may positively influence safety, efficiency, satisfaction, and more (Skinnarland and Moen 2010; Skinnarland 2011).

(4) 4 out of 10 respondents experienced no change from previous projects in terms of delivery to the specified quality. Nearly 60 percent did report an improvement. Inter-

view data suggest that improvements were caused by project participants showing more respect for other trades' finished products, and an increased awareness of dependencies and optimal order of activities, leading to less rework.

(3) An important issue in LPS is the understanding of the seven preconditions according to which tasks are made ready for execution. This means that work packages (tasks/activities) have seven preconditions in order to be 'sound' or 'healthy' – that is, they can be undertaken without any delay. Remarkably, several respondents were unfamiliar with the term 'seven preconditions' (Ballard, 2000, Koskela, 2000, Bertelsen et al., 2007). As 'seven preconditions' is a central term to understanding LPS, and often included in information about the LPS, it seems that the practice of analysing sound activities by seven preconditions differ from what is taught in kick-off seminars and included in LPS brochures.

"I've seen it on posters, but cannot remember them…"

(2) In terms of human injuries on the construction sites, nearly 6 out of 10 experienced no change from previous projects. This can be explained by an already strong focus on HSE work, i.e. that best practices to avoid injuries were probably already established. However, at the same time close to 40 percent did report an improvement, which may indicate that safety issues often may be included in the agenda in progression planning meetings, as part of the preparation for the execution of activities.

"Since you meet and discuss activities in a little more detail, rather than sitting at your desk alone writing a work schedule, I think probably more critical operations in relation to HSE has been detected."

(1) Approximately two-thirds of the respondents did not experience any change concerning damage to equipment and materials, whereas a third reported a slight improvement. Many respondents pointed out that organising work in zones (Skinnarland and Moen, 2010, Skinnarland, 2011), resulted in trades being able to work uninterrupted, thus reducing the amount of such damages.

Overall high scores

In terms of the remaining statements, between 68 and 75 percent of the informants gave scores of 'change to the better'. These statements include (13) Keeping deadlines, (12) Time spent waiting, (11) Correct information, (10) Control with progress, (9) Delivery with few errors, (8) Limited fire-fighting activities, and (7) Limited stress.

(13) 25 percent of the respondents did not find any change from previous projects regarding keeping deadlines. 50 percent found that keeping deadlines had improved slightly and 25 percent believed keeping deadlines had improved much.

> *"We deliver two and a half months earlier. We really should have been busy, but everything has gone so well."*

A large proportion of the respondents, 74 percent, experienced an improvement with regard to meeting deadlines. This is important because compliance with deadlines often may be synonymous with economic outcomes. Milestones reflect deadlines in the course of the projects, and increased attention to meet intermittent deadlines/milestones in the projects may increase the likelihood that handover deadlines would also be met. Some project managers experienced less need to use overtime work or delivered the final project earlier than planned.

(12) Two thirds of the respondents found that time spent waiting, mostly for other trades to finish their jobs, did improve.

> *"Everyone wants to do a good job and deliver good quality, and then they must commit. Everyone needs predictability in their work, so this [Lean Construction] is genius."*

(11) It is challenging to establish a structure that allows for necessary information about processes and production to flow between participants, between project phases and between various planning levels. By establishing a meeting structure where specific planning levels (time horizons) were systematically addressed, and by involving even subcontractors in these meetings, 75 percent of the respondents found that a greater degree of necessary information was distributed within the project.

"It's a good thing that you are involved early on in the project, and get the right information."

"I learned incredibly much from working in an interdisciplinary setting. We got more information to coordinate activities from."

(10) 75 percent of the respondents felt that control with progress had been slightly or much better. The following statements point to some explanations for this effect.

"Production is running smoothly now, we have gained progress control."

"Phase schedule planning has resulted in a more predictable work schedule."

"We have better control of each trades' plans. Although not always 100 percent certain, I still have felt more secure. In the progression planning meetings we have better time to think about and plan with others."

"We involve people to gain control so that things are predictable and that information is dispersed."

There was an increased focus on all subcontractors' schedules and on the dependencies between trades and activities. Progression planning meetings provided an arena for such awareness to increase. By involving other trades in planning meetings, discussions and information vital to the overall process also helped increase predictability.

(9) Three out of four respondents felt a change to the better in terms of deliveries with few errors. Several of the informants noted a difficulty with the finishing step. The term 'finished - finished' was explained as the last few bits and pieces which were not in place; minor errors, 98 percent finished, such as, e.g. grouting joints. Many still found the final phase to be as difficult in terms of chaos and minor deficiencies as in previous projects. One informant suggested a way to improve the project delivery phase:

"We need to have more focus on finishing properly whatever activity we are doing, rather than getting started on the next one."

(8) More than half of the respondents experienced slight improvements in terms of less execution of activities as fire-fighting activities. Lean methodologies was reported to be a desired collaborative practice since it was perceived to be a tool to bring problems to the table, to enable discussions and conversations, and finding mutual solutions. Forcing project participants to think and act according to progression needs thus helped avoid stress and fire-fighting.

(7) Although a third of the respondents experienced no changes in the level of stress, the majority of project managers and foremen did find that the methodology helped them implement projects more efficiently and with less stress.

> *"The subcontractors make a point of the low level of stress in this project, which is very good."*

Some informants described improved collaborative relationships characterised by the absence of stress and a sense of having more relaxed and predictable working conditions. 67 percent of the respondents experienced either a slight improvement or finding it much better. Their own explanation for this was the presence and involvement of all project participants, both subcontractor workers and managers, throughout the construction process. Involvement increased contact with others working on the project.

Figure 5.1 on page 91 shows indications of experienced effects and outcomes of implementing lean principles among project managers and foremen. To test the significance of these findings, an attempt was made to test one relationship.

a) Is there a significant difference in perceived effects and outcomes among project managers and foremen in terms of no change, slightly better and much better?

Relationship a) was tested using a chi square test for independence. This relationship could be tested since the observed number were derived by adding up the total of foremen 'no change + foremen 'change' + project managers 'no change' + project managers 'change'. The resulting sum was thus derived from, e.g. foremen choosing 'no change' on any of the 17 statements, giving a total of 76, + project managers ticking 'no change' on any of the 17 statements, and so on.

The null and alternative hypotheses to be tested were:

H0 The response given is not related to the position (The variables are independent)
H1 The response given is related to the position (The variables are not independent)

An Alpha level (significance level) of 0,05 was chosen, meaning a five percent chance is taken of wrongfully rejecting the H0 hypothesis.

With two rows and two columns in the data set, a degree of freedom of 1 was calculated;

(r-1)(c-1)=(2-1)(2-1)=1 x1= 1.

A five percent significance level with 1 df gives a critical value at 3.841

This can be demonstrated as follows. The area to the right of the critical point of 3.841 is the rejection area, meaning if the calculated statistics falls in this area, the H0 hypothesis is rejected.

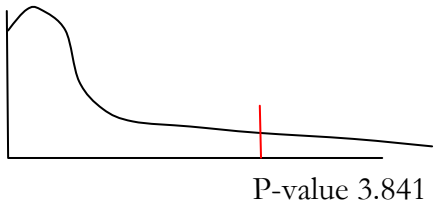

Figure 5.2 Chi square P-value

Decision rule was:
If X^2 is greater than 3.841, reject H0
First, observed and expected values were calculated.

OBSERVED VALUES/EXPECTED VALUES			
	no change	**change**	**Total**
Foremen	76/87	205/194	281
Project managers	85/74	154/165	239
Total	161	359	520

Table 5.3. Observed and expected values.

Source: author.

The calculations gave a chi square value of 4.38 with 1df (Degrees of Freedom).

Decision was:

Reject the H0 Hypothesis at the five percent level of significance.

H0
The response given is not related to the position (The variables are independent)

In other words, as H0 is rejected, we conclude that there is a dependency between the position held by the informants and the response given to whether there have been any perceived changes in outcomes and effects.

Limitations to the data

It needs to be pointed out that the sample size is very low in this research, and is not collected randomly. Rather, judgement sampling was used. The objective was to select project managers and foremen from this company who had experiences of conducting construction projects using a Lean Construction approach. Testing the significance of this relationship thus may be biased in terms of generalisation of the findings to the whole population of project managers and foremen.

Foremen seem more satisfied

Table 5.4 on the next page, provides the percentage distribution between foremen and project managers. In this table 'Slightly better' and 'Much better' is combined in 'Change to the better'.

	No change		Change to the better		
	PM	**F**	**PM**	**F**	**Total**
Control with progress	15.6	9.4	28.2	46.9	100
Mutual responsibility	9.4	12.5	34.4	43.7	100
Meeting structure/planning levels	3.2	6.5	41.9	48.4	100
Seven preconditions	20.0	23.3	23.3	33.4	100
Right information	15.6	9.4	28.2	46.9	100
Arena for collaboration	0.0	12.5	43.8	43.8	100
Time spent waiting	12.5	12.5	31.3	43.8	100
Keeping deadlines	12.5	12.5	31.3	43.7	100
Delivery within budget	26.1	8.7	21.7	43.4	100
Delivery to right quality	16.1	25.8	32.3	25.8	100
Few injuries on people	33.3	23.3	13.3	30.0	100
Few damaged material	37.9	27.6	10.3	24.1	100
Delivery with few errors	19.4	6.5	29.0	45.1	100
Well-being on site	9.7	12.9	38.7	38.7	100
Limited stress	19.4	12.9	29.1	38.8	100
Limited firefighting	13.3	13.3	33.4	40.0	100
Tidy workplace	19.4	19.4	29.1	32.3	100

Table 5.4. Percentage of qualitative responses to statements.

Source: author.

A qualitative assessment of table 5.4 suggests that, overall; foremen seem more satisfied with the effects and outcomes than project managers. In particular, there are three statements on which the percentage differ significantly (however, not statistically). Foremen seem to have experienced a 'change to the better' to a larger extent than project managers in terms of 'Control with progress', 'Right information', and 'Delivery within budget'. Again, in terms of the latter statement, remember that responses were made on the basis of several first and still on-going projects, and that some informants chose not to take a position on this question, resulting in only 23 responses. The picture that emerges from table 5.4 is supported in the interview data.

Tables 5.5 and 5.6 provide an overview of positive and negative experiences reported in interviews with implementing collaborative planning. Interview data was structured along three dimensions; a) process control and overview, b) relational and intrinsic value, and c) organisational and structural aspects.

Process control and overview	Relational and intrinsic value	Organisat./structural aspects
Positive	Positive	Positive
control with subcontractors' work	increased respect	
time saved by phase schedules	more involved and informed	
more carefully reviewed processes	increased wellbeing and motivation	
receiving frequent reminders	asked for advice in early phases	
subcontractor stable precense	learning from interdisciplinary work	
	increased commitment /demands	
	pushing each other	
	improved dialogue with supervi-sors	
	more people take responsibility	
Negative	Negative	Negative
		lack of initiative from management
		post-it-planning - perspective
		lack of design drawings

Table 5.5. Foremen experiences as reported in interviews.

Source: author.

Table 5.5 shows that positive foremen experiences were related to issues concerning process control and overview, and to relational and intrinsic values.

Process control and overview	Relational and intrinsic value	Organisat./structural aspects
Positive	Positive	Positive
identify HSE issues	understanding of design process	early clarifications
detect and avoid trade collisions	Increased ownership	system planning and collaboration
	increased job-satisfaction	plan transparency
	more open environment	ability to plan further ahead
	post-it-planning - discussions	
Negative	Negative	Negative
difficult final phase (no change)	not all promises kept	lookahead meetings abstract
	limited sense of collaboration	lookahead meetings not focused
		meetings take too long
		lack of design drawings
		lack of support in implementation
		mixed focus – operation/ planning
		mix of meeting structure

Table 5.6. Project management experiences as reported in interviews.

Source: author.

To the extent that foremen reported negative experiences, these were connected to organisational and structural aspects of implementing collaborative planning. A corresponding table is presented for project management experiences.

The overall impression of table 5.6 is a shift towards the right, indicating a shift in focus towards organisational and structural aspects. When assessing their construction projects in terms of LPS, project management seemed to put a larger emphasis on organisational and structural aspects, reporting both positive and negative experiences. Both foremen and project management seemed to be concerned with relational and intrinsic value gained or not achieved in their projects.

Conclusion: Overall, both foremen and project management reported positive effects and outcomes of implementing collaborative planning methodologies in their construction projects. Foremen generally seem to report more positive experiences than project managers. Interview data suggest that foremen and project managers tend to differ in terms of which dimensions of conducting projects they emphasise.

Particular challenges faced

Some informants experienced a challenge in focusing on longer planning horizons in progression planning meetings. This was partly explained by the perceived increased level of abstraction when planning for many weeks ahead. Some project managers solved this by developing the communicated plans. In general, this was done by narrowing down the scope of planning in Microsoft Project or equivalent programmes, from showing months to, e.g. only the next eight weeks. Other explanations were subcontractors being self-protective and thus not willing to become really involved, some even choosing not to attend meetings. There was a tendency noted in the interview data that project managers who communicated clear expectations concerning behaviour and attitudes towards meeting participation, to a larger extent than those who did not, experienced less subcontractor protective behaviour.

Some managers experienced a difficulty in motivating conversations, and a lack of preparation led to poor communication and dialogue in meetings. Several project managers attempted to solve these situations by establishing and communicating a defined purpose in meetings, and clearly communicating to participants what was required of them in terms of preparation for meetings, engagement in meetings, and following up on commitments to agreements made in meetings. By involving more participants in

progression planning meetings, more expertise was utilised, providing more optimal solutions. Further, project participant relations were strengthened as they became better acquainted with each other on a personal level, which helped increased their commitment and understanding of each other's challenges.

A challenge was experienced in projects that were established within traditional structures and routines, and then a lean structure was implemented. Some felt that rather than constituting a change from traditional to lean structures, LPS became an addition to the existing structure. A related challenge was becoming involved in a new construction project at the same time as finalising a different project. However, informants pointed out that there was less overlap between the projects now than previously.

Involvement may have some challenging aspects. One is establishing the optimal form and scope of involvement, both in terms of own employees and subcontractors. A project manager pointed out a challenge with fully involving workers and even apprentices, and stressed the need to make them collaborate with, and learn from senior staff, and thus better understand their production requirements. This was articulated as follows:

> *"The biggest challenge for me is to involve even the apprentice boy, to make them work together and to understand what they are producing."*

A third aspect was to involve project participants who entered the projects at later stages.

Conclusion: The main challenges described concerned adaptation to longer planning horizons, transition to new meeting structures and letting go of traditional ones. Some informants found chairing and implementing meetings challenging with regards to motivating dialogue and communication. Various aspects of involvement were also claimed to be challenging.

Drivers for use of LPS methodology in future projects

Virtually all respondents expressed a wish to implement Lean Construction also in future construction projects. Arguments provided were perceived increased participant commitment; an increased ability to coordinate trade activities; to highlight problem areas; and to discuss and find common solutions.

According to the respondents there were several drivers for future use of LPS. One driver was dedicated lean enthusiasts; own employees both on organisational and project level, who can direct the processes of implementation and development of lean practices. Another crucial driver was that top management must communicate an expectation that lean practices, as a collaborative work practice, are implemented in all construction projects. Also, a driver was noted in terms of getting subcontractors involved and for top management to receive help 'to sell' the benefits of the collaborative approach to potential subcontractors, as expressed by one of the project managers:

> *"There is a need for training and marketing job to be done. It's the marketing that makes them see that they really can benefit from this."*

Knowledge about the methodology was reportedly also an important driver of future projects. Practical and theoretical information and training increased understanding, not only for what to do, but also why.

A few informants found it difficult to accept the idea of changes to current project practices, and pointed out that support from lean experts within the company had been helpful. Since many project managers were still in the early phases of adapting to lean principles, such support may be a key driver also in future projects. Another important driver was that costs were in fact reduced, and errors limited. It was stressed that ultimately project managers needed to experience financial pay-offs from lean practices.

Conclusion: In order to use collaborative planning methodologies in future construction projects, key drivers were identified consisting of key personnel to direct the development processes, top management engagement, further practical and theoretical knowledge of lean understanding, and support from external or internal lean experts.

5.2.4 Summary Part I

In general, findings reported in current research support findings made by other researchers described in the literature review chapter. Also, barriers noted in the current research are known barriers reported by other researchers. This may indicate that construction companies are likely to experience and work to overcome the same obstacles in their own projects, as part of a natural learning period and transition from traditional to lean practices. At the same time, it seems that similar effects and outcomes are expe-

rienced independent of geographical location. This is a conclusion which cannot be determined on the basis of this research. Nonetheless, future research may show whether national differences in labour traditions and culture may affect implementation of LPS.

The analysis in Part I suggests that the use of Last Planner System in carrying out construction projects is perceived by project managers and foremen to have resulted in positive outcomes and effects. Research thus support the relationship suggested by the literature review, that

X is related to Y

This means that various types of joint interaction, project group, inter-organisational team effort (X) may result in various types of outcomes; such as increased productivity performance, or other performance measures and goal attainment (Y).

In part I of the DBA programme the research question posed was:

"Can collaborative progression planning tools be used to improve project delivery in construction projects in Norway?"

Based on findings noted in this chapter, the hypothesis was strengthened, that there is a functional relationship between the use of Last Planner System as a collaborative working methodology, and project managers' and foremen's experiences with conducting construction projects. Also, the second hypothesis was strengthened, that there is a functional relationship between the use of Last Planner System as a collaborative working methodology, and project managers' and foremen's experiences with effects in the form of project delivery.

Although the data may be too limited to generalise, it still offers valuable insight into experiences within the contexts described.

5.3 Part II

5.3.1 Introduction Part II

In part II of the DBA research project two construction projects from two different construction companies were closely followed over a ten month period ending in the third quarter of 2012. The main purpose of the study, based on a case study approach, was to explore how collaborative progression planning processes may help develop collaborative relationships in Norwegian construction projects. Both of the construction companies represented in this study had integrated collaborative planning methodologies into their organisational development strategies; however, the length and maturity with the planning approach differed between the two.

In the course of the case study research, semi-structured in-depth interviews were conducted, planning meetings were observed, and relevant project strategy documents were studied.

About the case study construction projects

The case study companies are described in appendix A, on page 210. Case study construction project A (Case A hereafter), was an apartment building construction project where the company itself was the owner and developer. The building project consisted of construction phase 3 and 4 of a development project which started in the second quarter of 2011 and were completed in the third quarter of 2012, with a duration of 20 months. Each of the two construction phases consisted of three apartment buildings. The first two construction phases were built in the period from 2006 to 2008.

The construction project was located within a district of the main company where the collaborative planning methodology has been implemented and refined over the last decade. The district office is known to be in the forefront in Norway in deploying collaborative planning methodologies and involvement within their project operations. The size of the building in monetary terms was GPB 16.2 million and consisted of approximately 70000 ft² Gross Floor Area (GFA), in addition to a parking-basement of 21500ft² GFA. The building project was built under a turnkey contract, with less than 50 % of the total work packages carried out by the main contractor.

Case study construction project B (Case B hereafter), was a new commercial building in the western part of Norway. This construction project was partly owned and developed by the main construction company. The project was estimated to last for 20 months at a

price of GBP 28.1 million. The new commercial building consisted of approximately 151000ft² office space and approximately 43100ft² of parking areas.

	Case A	**Case B**
Type of construction	New apartment building	New commercial building
Geographical region	Middle of Norway	Western part of Norway
Duration	20 months	20 months
Project size (monetary)	GPB 16.2 million	GBP 28.1 million
Project size (metric)	70000 ft²+21500ft² parking	151000ft²+43100ft²
Type of contract	Turnkey contract	Turnkey contract
Ratio of own employees to subcontractors	Less than 50 percent own employees	Less than 50 percent own employees

Table 5.7. Case project facts and figures.

Source: author.

About the project managers' experiences with collaborative planning

The project management in case A was relatively experienced with the collaborative planning methodology and the project manager and operations manager had conducted several construction projects using this approach previously, although this project was their first joint project. In case B the project manager had a long experience of running projects, however, this was the first project in which collaborative planning was implemented. From the outset he (case B) was motivated to use the new approach realising that the involvement factor could help overcome previously experienced obstacles to production flow, caused by suboptimal planning. The project manager in case A made some adjustments and refinements of the routines and practises followed in projects prior to the case study project (case A).

About the informants

The informants in this research included project management, foremen, team supervisors, skilled and unskilled workers, and apprentices. In case A, 3 people from project management (project manager, site manager and operations manager) representing the main contractor, were interviewed. This was matched with three subcontractor project managers. Two foremen from the main contractor were interviewed, and one subcontractor foreman. A total of five team supervisors were interviewed, of whom three came from the main contractor. 12 workers were interviewed, seven from the main contractor and five subcontractor workers. This provided a total of 26 informants in case A, 14 main contractor informants, and 12 subcontractor informants, (see appendix table 3, on page 215.)

In case B, two people from project management (project manager and operations manager) of the main contractor were interviewed, in addition to a project manager trainee. Three subcontractor project managers were interviewed. One foreman from the main contractor was interviewed, and two subcontractor foremen. A total of five team supervisors were interviewed; two main contractors and three subcontractor team supervisors. Two of the subcontractor team supervisors were interviewed as a group. 11 workers were interviewed, out of which four represented the main contractor, and seven subcontractor workers. This provided a total of 25 informants in case B, 11 main contractor informants, and 14 subcontractor informants, (see appendix table 4, on page 216).

Observation

Interviews and observation were organised in eight visits to each of the construction sites over the ten month period. In case A, three levels of progression planning meetings were observed, and on two occasions, other project related meetings were observed. In case B, two levels of planning meetings were observed.

In case A, eleven team meetings were observed. This was a meeting for the main contractor workers teams and was chaired by the team supervisor. In this meeting a team plan was produced for the coming week. The team meeting was a meeting in which tasks were planned and coordinated at the individual level.

The team supervisors were observed in seven meetings. This was a weekly meeting in which main contractor and subcontractor team supervisors together reviewed and updated the weekly schedule, mainly for two, but up to five weeks ahead.

Seven 'lookahead' meetings (operations meetings) were observed. The lookahead meeting was a weekly meeting in which main contractor project management together with subcontractor project managers or officers reviewed and updated the lookahead plan, about five to nine weeks ahead of task execution.

The two observed project-related meetings, which were not arenas for planning purposes, were a project design meeting, and a company specific meeting in which management and workers attended to receive information about project economic status, discuss HSE related issues, and to review a monthly job satisfaction survey among all main contractor employees on the project. In the design meeting, site project managers and design managers, architects and consultants, and the builder, attended to discuss design matters.

Type of meeting	Number of meetings
Team meetings	11
Team Supervisor meeting	7
Lookahead meeting	7
Project Design meeting	1
Company specific meeting	1
Total	27

Table 5.8. Observation case A.

Source: author.

In case B, fifteen meetings were observed, out of which eight were team supervisor meetings and seven were lookahead meetings.

Type of meeting	Number of meetings
Team Supervisor meeting	8
Lookahead meeting	7
Total	15

Table 5.9. Observation case B.

Source: author.

Appendix A.2, on page 213, provides an overview of the various meetings, frequencies and purposes. The various roles in the projects are explained in appendix table 2.

5.3.2 Data collection and analysis Part II

Research questions and hypothesis

The research question addressed in part II was explorative in form, and the aim was to study *how* collaborative progression planning processes may help develop collaborative relationships. This study addressed conclusion number II from the literature review synthesis. Literature showed that in order to accomplish various types of project outcome, it is vital to address how collaboration may be developed and sustained, and to learn about the barriers to collaboration as well as the social conditions under which collaboration is to take place.

Thus, in this section of chapter five, the following research question was studied:

"How can collaborative progression planning tools be used to increase the degree of collaboration in construction projects in Norway?"

In this section, research builds on the collaborative dimensions selected to explore the development of collaboration in this research, referred to on page 64.

Research objectives

The research objectives in Part II thus are designed to test:

1) How the use of progression planning tools may influence the degree of familiarity and common goal setting in the construction project.
2) How the use of progression planning tools may influence the degree of involvement and communications in the construction project.
3) How the use of progression planning tools may influence the degree of conflict in the construction project.
4) How the use of progression planning tools may influence the degree of motivation in the construction project.
5) How the use of progression planning tools may influence the degree of awareness of each other's perspectives in the construction project.
6) How the use of progression planning tools may influence the degree of predictable working processes in the construction project.

Data collection Part II

Data in Part II was collected over a 10 month period using semi-structured interviews, both individual and group interviews, observation in meetings and a study of relevant project documents. The interviews and observations were conducted with regular intervals in the course of the case study period ending in the third quarter of 2012. The interviews lasted from 60 minutes up to a maximum of 90 minutes. All interviews were conducted on the building site, as this arrangement was agreed to cause the least disturbances and inconvenience to the informants. As participants enter and leave a construction project at different phases, interviews and observation were conducted at several points in time in the fieldwork period. The main aim of the spread of interviews was to explore the same issues with later project entrants. Informants were interviewed once, except the project managers who were followed up regularly with questions concerning how the construction project was perceived to develop. In total for the two cases 26 interviews were conducted one-on-one. 9 interviews were conducted with two to

four informants present, mainly consisting of workers, giving a total of 35 interviews with all together 51 informants.

The main aim of the semi-structured interviews was to increase understanding of how the use of collaborative planning may influence the main contractor subcontractor relationships.

Progression planning meetings were observed. The combined approach of interviews and observations provided an opportunity to explore in depth specific issues emerging in planning meetings and to look for behaviour in meetings as discussed in interviews. The aim of the observations was to look for evidence of alleged collaborative development as stated in the interviews, and how such behaviour materialised in planning meetings. The combined approach was an important triangulation in studying the process of collaborative progression planning in meetings in which both the main contractor and subcontractors participated.

Data collected from interviews and observation

In studying processes of collaborative progression planning and how these may help in developing main contractor subcontractor collaborative relationships, the interview guide (shown in full text in appendix D, on page 233) addressed the following main issues:

- Project and production organisation
- Meeting structure and involvement
- Planning methods and routines
- Project collaborative culture
- Management roles in terms of collaborative planning

In progression planning meetings, issues such as general impression, participation, stakeholder involvement and communication patterns were observed and protocolled. (The protocol is shown in appendix E).

Data analysis Part II

Interviews were recorded and transcribed. The data material was then analysed using a qualitative, reflective approach (Argyris and Schon, 1996). This approach to analysis enabled reflections of the emerging issues, thus, the analysis process was an on-going activity throughout the data collection period. A pre-developed interview-guide was

used; however, findings from interviews and observation were reflected upon, and thus the guide was adapted to explore these emerging themes and unforeseen events. In combination with the reflective analysis approach (Argyris and Schon, 1996), thematic analysis (Fereday and Muir-Cochrane, 2008) was used, as themes both emerged from the data as well as being introduced by the researcher. Thematic analysis is a step-by-step process of analysis commonly used in qualitative research. As themes were identified from the raw data, a sorting process started. Transcripts of interviews and protocols from observations were read multiple times. As data was collected at different points in time in the course of the case study, emerging themes were reflected upon and followed up in later interviews and observation. Then, as the amount of data increased, patterns of behaviour were recognised and categories of themes emerged (Fereday and Muir-Cochrane, 2008). No formal coding was conducted using qualitative data analysis software, however, transcripts were sorted and arranged according to the emerged themes to ease the analysis process.

5.3.3 Findings from interviews and observation

In the following, findings relative to the above main issues are described, based on the two cases which comprise this part of the DBA research.

Project and production organisation

Certain conditions may affect the implementation of construction projects, such as management staff, level of own production vs. subcontracts, and early events that may affect future production. In these two cases project management was staffed with roles such as site managers, operations managers, foremen, trainees and team supervisors. Managers were in charge of specific areas, such as project design, builder/owner contact, certifications programmes, and for planning processes.

Both construction projects subcontracted most work packages, except concrete workers (both cases) and carpenters (case A). In case A, some subcontractors had been involved in the two previous construction phases, and were familiar with the building design and with some of the project management group. Some also had been working for the main contractor using collaborative planning methodologies in previous projects.

> *"We have taken a lot of what we experienced there [CP1+CP2], we have taken it with us, and the architect company is the same."*

Case B experienced some problem with the ground work which delayed work, putting a time constraint on later construction phases. Also, throughout the project there was a lack of design drawings, which resulted in many changes to plans and priorities made on short notice.

Shared facilities

In case B, the project manager and site manager for the technical trades (combined sub-contract) were co-located with the project management. The co-location was claimed to have improved relationships with the main contractor as direct face-to-face interaction replaced lengthy e-mail correspondence.

> *"You come to know the people in a bit different way, which makes it easier to deal with difficult situations right away. Personally, I feel it is much easier to discuss things face-to-face, and rather write a summary in an e-mail afterwards."*

The shared facilities were reported to motivate a 'give and take' approach, rather than constantly pushing own needs and perspectives.

Further, team supervisors, both from the main contractor and the technical trades shared offices on the building site. This room was equipped with work stations, a table to facilitate meetings and to study drawings, and a Smart Board to show BIM design drawings (Khanzode et al., 2007). Some foremen and project managers claimed that such facilities shortened decision making processes since it motivated important discussions and problem solving among team supervisors, which would normally be dealt with on a foreman or project manager level.

> *"You can hide in a container office, but when your office is located with others', you talk with them and solve things, and you get to know them."*

Several of the team supervisor informants emphasised the role of personal relations between team supervisors in developing project relationships. Shared offices facilitated face-to-face conversations, informal information sharing, and the use of BIM (see page 41) to jointly study drawings. Informants suggested that the resulting collaboration prevented potential conflicts from evolving, and increased their understanding of the totality of the project.

Meeting structure and involvement

Kick-off seminars

In both cases multiple kick-off seminars were arranged at different points in time in the course of the projects. Kick-off meetings varied in terms of form and duration, who were involved, and purposes.

Most kick-off seminars were one day events at either company headquarters or the construction site, whereas in one instance the participants spent two days together out of town. Kick-off seminars early in the project typically involved main contractor and subcontractor project management groups, foremen and team supervisors. In addition, design managers, builders/developers, consultants and architects were reportedly involved. Kick-off seminars following the project start-up typically involved foremen and team supervisors, and in case A, even workers. Involvement in kick-off seminars was dependent on whether contracts had been signed at the time, the perceived importance of attendance, and purpose of the event. For example, main contractors chose to involve foremen or team supervisors in these seminars to a larger extent than subcontractors.

In case B, none of the team supervisors participated in kick-off meetings or phase schedule planning sessions. Team supervisors perceived the collaborative planning methodology as applied in the project to relate to kick-off seminars, in which foremen and project managers participated.

Kick-off seminar objectives

The informants expressed multiple goals with the kick-off seminars. Dependent on the purpose of the specific kick-off seminar, objectives could be to

- prepare a design delivery plan; a systematised overview of design needed/when
- become familiar with each other, since all were relatively new to the group
- let contractors present themselves
- provide information about the project, such as deadlines, design and HSE, and the construction stages
- let the builder/developer inform about the project and expectations
- present the meeting structure, emphasising the role of time horizons and correct order of activities
- provide information concerning collaborative planning
- arrange teamwork sessions
- jointly develop a phase schedule plan

The above list shows that objectives in broad terms were concerned with a) developing informal relationships, b) providing and sharing information, and c) producing joint kick-off seminar outcomes. As an example, one teamwork session was based on the builders' informed expectations and a challenge was issued to the group: "*Which specific actions can we take to meet the client's expectations?*" A result from this session was an action plan including all the participating trades. In case A, such action plans were also developed among workers. The action plan was then signed and posted on the wall in the meeting room.

> *"They [the workers] themselves define the areas to focus on, and the points should be specific enough to be able to measure it by putting a number on a scale."*

> *"Earlier you were never introduced to anything, you only knew that something was to be built, that's it. Knowing a bit more about how things will be, is very positive."*

In kick-off seminars, the site managers presented the phases of the project and the scope in terms of size and construction period, and the builder/developer presented his visions and expectations concerning, e.g. construction, handover, and warranty schedules. The participants found the builder's presence to be useful.

In phase schedule planning sessions, each trade wrote down relevant activities for the construction stage on coloured sticky notes (post-it-notes). Each trade had their own colour. Following discussions among the participants, the sticky notes were then placed on a wall-to-wall brown paper, in the right sequence of activities and with the expected length of time for each activity. Such sessions could cover design production, the stage until closed construction, and internal work. Following the brown-wall (post-it-note) session, the site manager transferred the resulting phase plan to Excel.

Effects of kick-off seminars

The informants noted positive outcomes from participating in kick-off seminars, such as a positive chemistry and familiarity within the group.

> *"…[W]e know each other better, in kind of a different way, than what we wold have if we did not meet like that [out-of-town], and the other contractors know who our team supervisors are, and is familiar with our roles".*

"It is all about getting to know each other and to build trust and confidence in each other."

The personal relationships reportedly helped create trust among the group of participants. Subcontractors were involved in discussing the correct sequence of main activities, the production line, and noted the importance of being able to let the other trade contractors know and understand how they wanted the fundament to be, and how they themselves could prepare the work area for the next team in line. Contractors took turn to tell about their needs in terms of progression and quality.

"Those who are present, get a clearer picture of how we all can contribute to get a good flow."

Other noted benefits from kick-off seminars were increased generosity and participants becoming more attentive towards each other; an increased awareness of dependencies; and a visualisation of the totality of the project.

"Already at the kick-off you have to think about the people around you, when you place the post-it-notes. I think much of the foundation is laid here"

Phase schedule planning reportedly positively affected relationships and participants' understanding of the correct sequence of activities. However, negative experiences and concerns were also noted from the phase schedule planning session. One concern that was pointed out was that not all work packages were contracted at the time, which represented a possible risk in estimating time. Some subcontractors expressed a feeling that the plan developed in the post-it-session later did not apply to real life.

Three levels of progression planning meetings

Progression planning in both cases was comprised of weekly team supervisor meetings and lookahead meetings. In addition, workers in case A were involved in planning for the coming week. In case B, neither the main contractor nor subcontractors had formal team meetings, only ad hoc information provided about planned activities.

Thursday week 0	Team supervisor meeting (main contractor)
Friday week 0	Draft plan to teams
Monday week 1	Team planning meeting (main contractor)
Monday week 1	Team supervisor meeting (all contractors)
Tuesday week 1	Lookahead meeting (all contractors)

Table 5.10. Weekly meeting structure case A.

Source: author.

Wednesday (every two weeks)	Lookahead meeting (all contractors)
Thursday week 1	Team supervisor meeting (main contractor)

Table 5.11. Meeting structure case B.

Source: author.

Team meetings

In case A the preparation for activities in the coming week started every Thursday of current week. The main contractor team supervisors together with the foreman and operations manager worked out a draft work schedule for each team for the next week. Coloured 2D drawings showing activities planned per team were handed out to the teams before lunch on Friday. The teams were then expected to check whether suggested activities were achievable according to seven preconditions, e.g. if they had the right materials, equipment, manning etc. to be able to commit to this work schedule?

On Monday morning the team supervisor chaired the meeting in which teams of 2 - 3 workers took turns in presenting to the other teams (e.g. other carpenters teams), what they were going to do, where they were to be working and when. Any conflicting issues would emerge at this meeting, e.g. prerequisites to carry out tasks: *"I need the plumber to finish before I erect this wall, will he do that by Wednesday?"* As one member presented the team weekly plan, other participants asked clarifying questions and made comments if work needed to be coordinated. The meeting chair actively invited workers to give input.

> *"I tell them that if they feel they have any input, then bring it on, it is after all their meeting."*

Provided the issues/obstacles brought up were taken care of, the teams then committed to their work schedule by signing off on a smart board 2D drawing of the assigned work area. Any questions raised in this meeting that could not be answered properly, were brought to the next level of meeting, the team supervisor meeting.

Workers emphasised the need for them to be prepared for the meetings.

"If you're not prepared, you feel that you have to prepare better the next time, you have to think more about what you're doing, and become more interested, you have to think for yourself."

Being prepared meant having received the 2D drawing and made a thorough check on each activity to verify that it could be executed according to plan. In this way a two-way communication took place in the team meetings, rather than one way information communicated by supervisors.

Sharing information in team meetings reportedly not only saved time, but secured that relevant information was received accurately. Without this meeting, supervisors claimed they would be limited to conveying information on an unreliable ad hoc basis.

Workers pointed out that their involvement in weekly planning enabled them to prepare for the weekly activities, and to conduct hazard and risk analysis, thus taking more responsibility to keep overall progression within a safety work environment. When team members presented their weekly activities they felt involved, seen and heard. Workers noted that the active engagement in meetings was a motivation factor.

"It is important not only to use our hands and feet, but our heads too."

Workers said that they perceived a sense of real influence on the draft plan, in that they could provide input, such as how to improve work processes, any technical solution, and order of activities. For instance they could point out that a different order of activities was better in terms of crane availability. Involvement in meetings created more predictable work days and workers became less dependent on their supervisors and foremen since they, to a larger extent, knew what to do. That meant they were left to produce more efficiently, rather than spending much time readjusting to new assignments.

Team supervisor meetings

Team supervisor meetings were held weekly in both cases. The site facilities provided were large and bright meeting rooms with technical equipment such as smart boards and overhead projectors. Meetings usually lasted between 60 to 90 minutes. On the one hand, informants stressed the need to reduce the length of meetings, while on the other hand enjoying positive effects of receiving information, finding joint solutions and having direct communication and problem solving between contractors.

The foreman chaired the team supervisor meetings in both cases. Besides him, both main contractor and subcontractor team supervisors were invited to participate. In case B, a trainee was present in all meetings.

The aim of the team supervisor meetings was to plan for and coordinate activities for the next three weeks. The three weeks planned for were excerpted from an eight week plan to be considered by the project management level. Trade dependencies were discussed. Other points on the agenda were HSE, trade status updates and discussing eventual activities behind schedule.

The general impression was that most contractors' team supervisors participated. Meetings were observed to start on time without delays or small talk. Any unanswered questions from team meetings were addressed. In general there was a nice and relaxed tone of voice. All got to speak uninterrupted and many took part in discussions.

Contractors prepared for the meeting by checking status, and then informed other participants of their status, any problems or concerns. Relevant trades discussed and found solutions concerning order of activities and dependency issues.

> *"You get kind of an ownership, when you inform the others yourself of where you are and when you plan to finish. Then you get more ownership and maybe work harder to reach that goal, than if you were simply told when to finish."*

Team supervisor meetings were perceived to be important because communication was systematised. In earlier projects, team supervisors would raise issues and discuss them out on the building site. But their decisions were not necessarily coordinated with a third party.

Lookahead meetings

In lookahead meetings project management from the main contractor and project managers or officers from each subcontractor, met to plan for the next eight weeks, to dis-

cuss particular concerns to the plan, and to remove any obstacles that could delay or hinder future production by discussing the order of activities and trade dependencies. Any concerns from team meetings or team supervisor meetings that had still not been solved were raised and solved at this meeting, and information fed back to team supervisors or workers.

In case B, although all contractors were invited to participate, occasionally not all did attend, sometimes with the consequence that matters that needed to be solved could not even be discussed. Some participants actively engaged in discussions, while others were more reserved and quiet. Subcontractors emphasised cause and effect of being involved in lookahead meetings.

> *"The more you involve yourself, the more engage you become and the more you get out it yourself. Those who are likely to be less prepared, they just sit there and say as little as possible."*

Although the aim was to plan for the next eight weeks, case B experienced some difficulty in obtaining this time perspective. Focus shifted from the next two weeks, to a longer time horizon than six weeks, resulting in too many issues to resolve, and lengthy meetings. In case B, lookahead meetings took up to two and a half hours and generally it was expressed that meetings lasted too long.

Some subcontractor project managers expressed that there was too much focus on what did not work.

> *"According to the plan, we are behind schedule, and then we keep focusing on why. Maybe we ought to revise the plan so that we talk to a plan rather than talking about why we are so much behind."*

The project manager in case B, expressed a difficulty in motivating necessary discussions about dependencies. Much of the communication was felt to be one way.

Effects of lookahead meetings

Informants in general found the lookahead meetings to be positive to collaboration and to the progress. Discussions in meetings enabled collisions between activities to be detected and avoided. As one subcontractor project manager noted,

"By looking at activities eight weeks ahead, contractors get important reminders. This is the basis for planning staff and ordering material and equipment. If one is preoccupied with current production and problems, one tends to forget such things as ordering deliveries and planning staff".

Lookahead meetings were claimed to result in a more open dialogue and improved relationships between the contractors. Informants noted that participants who engage themselves experienced benefits, since they were able to see the benefits to themselves of helping each other.

"The more you know people, the more considerate you become, I feel. Lean has made us more aware of each other's needs."

Planning methods and routines

Course of action

In case A, lookahead meetings were chaired by the site manager together with the operations manager. One paid full attention to and led discussions, leaving the other to concentrate on taking notes and updating minutes. Further, the dual attendance both demonstrated project managerial strength and that this arena for collaboration was important to them.

Participants provided progress status, if they had particular problems or concerns, and if there were dependencies towards other trades. The chair asked if there were any obstacles to coming activities, using a systematic review of the seven preconditions on each activity. A coloured code was used, green for activities free of obstacles, red for activities with obstacles that still needed to be removed. The review of coming activities demanded that all contractors prepared by consulting with their foremen and team supervisors. The operations manager noted a lack of preparation at times.

Discussions revolved around coming activities and interdependencies, sequences of activities and consequences. The updating of the progression plan implied a marking from red to green of activities that was ready to be conducted, i.e. all seven preconditions were met, and thus visualising how each contractor could contribute to an overall optimal project process.

Use of agenda

In case A the informants emphasised the importance of relating to a fixed agenda to structure discussions, which mainly focused on production, inter-trade dependencies, sequences of activities and removing obstacles to production. First on the agenda in meetings on all levels, was a presentation of the latest HSE report. The report contained pictures with a description of issues concerned, and who (person or trade) was responsible for correcting the matter. As the report was presented, the participants would comment on any matters that had already been corrected, or they would commit to correct matters. Matters were raised regarding the main contractor, just as much as subcontractors. A Smiley of the week was awarded for a particularly positive finding in the HSE inspection.

In team supervisor meetings, a Construction Job Safety Analysis (CJSA) for activities to be performed the next week was discussed. One example of such a CJSA was based on the weather report (one of seven preconditions), where they needed to discuss eventual consequences.

Next on the agenda were quality issues. Notes of quality deviations (e.g. paint spills in flats, damage to finished products) were handed in at the project office and systematised into a weekly report and followed up in meetings.

Then a review of the progress status for each trade followed, and a review of the progression plan for the next planning period. This part of the session was structured in terms of specific construction phases, apartment buildings, work zones, floors and trade dependencies.

> *"They [main contractor] care about the things that are important, and are not picky about the things that are not important."*

Finally, each trade took turns informing whether they were on schedule, if they would complete the planned activities, or if something would cause delays. Concerns raised that were not strictly within the agenda, were urged to be dealt with by the relevant trades after the meeting.

Progression planning

In case A, the time horizon for planning in lookahead meetings was eight weeks, meaning a rolling eight week plan was pulled weekly from the master plan. In this session, work not performed according to plan was marked with a red x on the plan prepared on

an Excel spread sheet. The spread sheet showed eight five day weeks, marked with x in days with activities, each x being coloured according to trade. In this session, progression planning and discussions were structured along the lines of construction phase (3 or 4), building (three buildings in each of the construction phases), floors, work zones and trades. As building site production involves uncertainties, such as, e.g. unstable weather conditions, staffing and material, priorities were given to certain work areas. Throughout the meetings preceding and subsequent activities were discussed, dependencies between activities and trades were discussed, and reminders of deadlines and milestones given.

Minutes, (e.g. reminders of special deliveries, local government approval, or quality concerns), were reviewed and updated.

Last on the agenda was the personnel status and plan for the coming weeks. Participants were then asked if they had anything more to add. This sequence was structured so that the chair asked each participant around the table if they wanted to add something. Minutes were written in the course of the meeting, printed and handed over to participants as they left the meeting.

In case B, several of the informants noted that the lookahead meetings often focused on which activities were behind the scheduled plan. While absent in case A, blaming occasionally occurred and some contractors seemed reluctant to commit and to make promises, since they could not be certain whether activities prior to their own would be finished.

Communicated plans

Plans were electronically communicated mainly using Microsoft Project or Excel. The level of complexity varied, and in case B, some confusion was observed to exist at times among the participants, as they found it difficult how to read the plan and to follow which activities were expected to be finished in the various weeks.

"It is green, but is it also started on or just ready to be started?"

"What are the red lines?"

In case B, there was not a fixed structure in what to present and in how to present progression plans, but rather developed as the project progressed. This was confirmed by the chair

"There is a constant need for adaptation in terms of how to present the plan."

In case A, an Excel spread sheet was used to present a detailed plan for the next three weeks in team supervisor meetings, an excerpt from the main process plan, with week four and beyond hidden, to keep focus on the coming three weeks. The activities in the three week plan followed a natural order of sequence, organised in construction phase (three or four), buildings, floors and trades. Each trade was given a specific colour on the excel sheet, which, according to the informants, simplified presentation.

Project collaborative culture

General impression

Informants generally described collaboration to be good, highlighting a relaxed and friendly atmosphere, and that all project participants seemed determined to find mutual solutions, although at times there was tension and boredom, and a negative attention and concern for deviations from plan.

An explanation provided for the perceived positive collaboration was that collaborative planning methodologies enabled more communication, thereby enhancing participants' understanding by being involved in meetings. Observations confirmed this.

Most of the participants seemed to be actively involved in discussions, e.g. in that they asked clarifying questions concerning other trades' on-going activities that could affect their own progress, and commented when necessary.

In general, the participants seemed to be well prepared and thus able to answer questions posed concerning future activities. Mostly, meetings were characterised by being solution-oriented, thus discussions for the most part involved finding solutions, e.g. in terms of optimal sequence of activities, use of crane and specific material delivery logistics.

Engagement levels

Engagement levels varied in the observed meetings, and in general engagement levels were higher in case A. In some case B meetings, the engagement level was perceived by some informants to be low. Observations confirmed this. These meetings were characterised by a one-way communication in which the chair (operations manager) asked questions that demanded a 'yes' or 'no' answer. Mainly, participants only answered when directly asked by the chair and were less active in initiating discussions.

In other meetings, many participants took active part in discussions, although some more actively than others. Preparation was evident, in that they were able to both ask relevant questions and to make relevant comments and answers. From observing in meetings it was noted that there was good eye contact between all participants, which may be interpreted as showing interest and respect.

Participants got to finish their sentences without interruption and the one who spoke seemed to have everyone's attention. The chair provided respectful and thorough responses to issues raised.

Another way in which engagement was evident was that participants actively took notes in small books.

Communication patterns

Discussions were structured in terms of who spoke when and about which topic and time perspective. As one trade informed the others about their status and plans, others asked questions for clarifications, or commented on any perceived consequences. Communications were largely characterised by a constant discussion of sequences of, and dependencies between activities, and removing any obstacles to future production activities.

Participants seemed clear on demands, both towards each other and towards the project management. Often such demands would be stated as a premise for keeping a promise. "*If you do this, then I'll commit to doing that*". All trades were equally treated, and the main contractor's own trades seemed to receive equal demands as subcontractors.

> *"So, I think that being heard, even though you are regular trooper on the site, that is important, that I find positive."*

Promises to each other were made throughout the meetings, commonly expressed in short confirming statements such as *"I'll see to that",* and *"I'll check that."*, and preconditions for keeping the promises stressed. Throughout the meetings participants clarified things and made promises to follow the agreed sequences of activities, keeping deadlines etc.

Contractors who were about to start on a new activity asked if dependent trades were finished. Contractors would inform each other of what they needed in terms of preparing for own activities, and how they planned to proceed. In this way all activities were

coordinated among the group of contractors. Trades would explain their work process and eventual consequences to them of other trades not following plan.

Participants discussed problems, raised concerns, explained needs and asked questions. Further, they suggested solutions, such as how to proceed with interdependent activities and pointed out responsibilities, dependencies between trades, and the need for other trades to handle finish products with care to avoid damage.

Communication

Informants claimed that communication had improved as a result of collaborative planning. A main contractor foreman had observed that communication patterns in team supervisor meetings tended to affect communication out on the building site. Even subcontractor workers expressed in interviews that it felt easy to approach the project management with questions.

Subcontractors explained that the good relationship to the main contractors was a result of access to the project management. Not only in terms of main contractor presence, but also in the perceived openness and accessibility demonstrated.

> *"These [project management] are people you can talk to. It is extremely important that they are easy to relate to. [It] gives you a good feeling when things get clarified; it gives you a sense of smooth working days."*

Subcontractors noted that the main contractor foreman spent most of his time out on the building site. His presence was perceived to be important for communication. The foreman himself emphasised the importance of working in proximity to own workers and subcontractors.

> *"Many questions emerge, people come up to me all the time to ask me questions, and I feel that I gain more from paying attention to what's going on out here, than by sitting inside. I want to be available."*

Management roles in terms of collaborative planning

The role of the chair of the meeting was observed to be an important factor in influencing communication patterns and engagement levels in progression planning meetings. The general impression was that meeting chairs, being foremen or project managers, had a good overview of process status, and thus were able to ask the 'right' questions,

and able to point out dependencies between trades and activities, e.g. *"Will that be a problem to you?", "How long time will you need?",* and *"Third floor is ready now, is that what you're saying?"*

The chairs were observed to use their positions and knowledge to urge necessary priorities. While chairs throughout the meetings expressed clear behaviour expectations from the participating trades in terms of keeping promises and following plan, they repeatedly demonstrated that these expectations equally applied to the main contractor own trades. Chairs were also observed to correct participants' behaviour, e.g. asking the electrician to make notes so that he would not forget what he promised in the meeting.

Motivating collaborative behaviour

To various degrees the chairs were able to motivate collaborative behaviour. One largely asked specific questions which demanded straight yes or no answers. His meetings often became lengthy and the chair tried to speed up the meeting by demanding full focus on progression. He often made comments that they were running out of time, and had to hurry.

Others managed to motivate the meeting participants to engage in conversations, discussions and in information sharing. This took several forms, e.g. by asking if anyone had something to add to the information given, or urging two or more trades to arrange separate meetings to discuss how to solve particular issues, e.g. concerning the right sequence of activities in a particular work zone. To various degrees, chairs would constantly encourage discussion and comments to be made, and to express promises. Some of the meeting chairs repeatedly made short statements, such as *"Good!"; "Well done!"; "Good to hear!"* which demonstrated that they were pleased with commitments demonstrated by participants.

The meeting chair could ask unambiguous questions such as *"Do you have enough time to finish?"; "Do you have the necessary equipment?"* The language was characterised by straightforward and unambiguous messages, questions and answers to make sure everything was thought of. The chairs used their positions to forge such clarity of language. Some would also summarise, and ask affirmative questions; *"That means we will be able to finish that floor as planned"; "So you're saying that you'll finish by next Thursday, is that correct?"*

Chairs also motivated discussions by relating questions to information given: *"How would what he is thinking affect you?"; "Do you have anything else?"* or *"Does anyone have comments or questions?"*

Involvement in discussions and collaboration between the contractors were motivated. The important role of the chair in encouraging involvement was described as follows:

> *"It is important to manage the meeting to achieve that level of communication. You can have the best meeting structure, but how you use it has everything to say, you can have the best plans and minutes in the world, but how you manage to get all participants involved, that is what matters the most, I think."*

Effects of collaborative planning

Informants generally considered the relationship between the main contractor and subcontractors to be positive, and many informants noted positive effects of collaborative planning, such as contractors showing more respect and understanding. Other effects noted were improved plans, less fire-fighting activities, and obstacles to production were detected and removed. Overall, it was reported to be more involvement than in projects without the collaborative planning approach, and extensive exchange of information.

Some of the subcontractor workers found that collaborative planning, to them, represented an increased management control resulting in suboptimal production flow to them. That implied reorganising work based on priorities from management. Information from team supervisor meetings was not perceived to always be passed on to all workers. Workers noted that availability of project management was good, but some had not noticed any benefits from team supervisors' joint planning, mainly because of their own team supervisors' lack of passing on information from meetings.

Although not all workers did express positive outcome in terms of more efficient production, they still claimed that relations were good, and had always been good. However, the following statement suggests that on reflection, some effects did occur.

> *"I was just thinking that I have been talking incredibly little to carpenters and other people in this project, so that suggests that it has been well planned and that we have flow."*

Some of the subcontractor team supervisor informants tended to perceive collaborative planning to be a management concern. However, a weekly joint planning session with all subcontractors was still new to them, providing an opportunity to discuss, solve problems and reach decisions on a low level.

Project managers reported that they benefited from a focus on progression on a longer time horizon than they were used to, although meetings were perceived to be time consuming and little engaging at times.

For the totality of the project, the project manager concluded that progression was controlled as a result of the efforts of the operations manager in reviewing the progression plans, and that the systematic review of activities weeks ahead was helpful.

> *«[We] have done it differently from what we used to, in that people have been allowed to express their views within a limited framework. In previous projects, I would have completed the full plan, taken it with me, and told everyone where and when to start, then made necessary adjustments along the way without involving anyone. I realise that I cannot always control every detail and I need the input from others."*

5.3.4 Summary findings Part II

The collaborative progression planning activities described above provide insight into how two construction projects were structured and managed. In case A, the setting was that, to a large extent, both main contractor and subcontractor participants were familiar with collaborative planning methodologies from previous project experiences. In case B, on the other hand, for many of the actors, the construction project constituted a first attempt at implementing collaborative progression planning methodologies. Findings can be sorted in terms of structures and procedures on the one hand, and communication and relations on the other. Both case study projects established a meeting structure adapted to maintain shorter and longer term planning horizons. Team supervisors planned for the shorter term planning horizons, while project management planned in a lookahead window of several weeks. In both cases, subcontractors were involved in progression planning.

Observation protocols from observing in progression planning meetings, combined with interview data, revealed several aspects of communication, such as the use of agendas and organising of discussion (who spoke when, about which issues). The role of the chair in stimulating dialogue and problem solving was emphasised. Planning

tools, such as Excel or Microsoft project, were used for progression planning purposes and as such also became a communicative tool in meetings.

The objectives in this part (II) of the research were constructed to test how the use of progression planning tools may influence various dimensions of collaborative relationships within Norwegian construction projects.

Research objective one

The first research objective was to test *how* the use of progression planning tools may influence the degree of familiarity and common goal setting in the construction project. Kick-off seminars were arranged with the aim to provide information about the construction project. To varying degrees subcontractors were invited to these sessions. A stated aim was for the participants to get to know each other and to familiarise with trades' needs and inter-trade dependencies. At some kick-off seminars joint planning sessions were arranged for the coming construction stage. In one of the case projects participants in kick-off seminars established and signed a collaborative agreement, stating how to best collaborate to achieve production efficiency. Both in kick-off seminars and in regular progression planning meetings discussions and conversations were stimulated to increase awareness and understanding of dependencies, to remove obstacles to production, and to find the optimal sequence of activities, so as to work towards common goals.

Conclusion: Progression planning tools may influence the degree of familiarity and common goal setting by establishing arenas for participants to familiarise with the construction project and each other.

Research objective two

The second research objective was to test *how* the use of progression planning tools may influence the degree of involvement and communications in the construction project. Data shows that project participants were involved in progression planning. In addition, the involvement element materialised in meetings as how management involved participants in discussions, stimulated constructive conversations, and generally increased levels of communication. The case descriptions point at management behaviour that may inhibit or promote communicative behaviour.

Conclusion: Progression planning tools may influence the degree of involvement and communications by inviting participants to project meetings, and in meetings by exhibiting a behaviour which stimulates engagement and communication.

Research objective three

The third research objective was to test *how* the use of progression planning tools may influence the degree of conflict in the construction project. Extensive interview data describe the importance of enabling participants to solve problems at an early stage and jointly find mutual solutions. Several informants emphasised the role of being brought together, and involved in communication in meetings, in increasing the levels of trust between the contractors and reducing the degree of conflict.

Conclusion: Progression planning tools may influence the degree of conflict by focusing communication in meetings on finding mutual solutions, and to attend to matters at an earliest possible time, so that matters are solved before evolving into problems.

Research objective four

The fourth research objective was to test *how* the use of progression planning tools may influence the degree of motivation in the construction project. Data suggest that motivation to commit to plans, and to take responsibility for keeping promises was evident. Main sources of motivation were, e.g. participants' increased understanding of the total process from being involved, a perceived higher level of respect and understanding from other participants, and increased control with progress.

Conclusion: Progression planning tools may influence the degree of motivation by involving and stimulating a sense of team. By making and keeping promises, trust levels increased, and so did motivation to engage and to commit to project collaboration and outcome.

Research objective five

The fifth research objective was to test *how* the use of progression planning tools may influence the degree of awareness of each other's perspectives in the construction project. A large proportion of communication in meetings centred on inter-trade or inter task dependencies, and on how to reach an optimal sequence of activity. Trade repre-

sentatives informed each other of specific needs to achieve optimal production flow. A continuous focus on task dependencies reportedly affected project participants' awareness of each other's perspectives.

Conclusion: Progression planning tools may influence the degree of awareness of each other's perspectives by focusing discussions and conversations on relations between participating contractors and dependencies between project activities.

Research objective six

The sixth research objective was to test *how* the use of progression planning tools may influence the degree of predictable working processes in the construction project. This objective has been stated as the most important ambition of implementing a collaborative planning methodology. Informants noted that collaborative relationships materialised in terms of predictability in participants' working processes. This was explained by the joint planning and removing of obstacles to future activities.

Conclusion: Progression planning tools may influence the degree of predictable working processes by continuously addressing possible obstacles to future tasks, and stimulating the commitment to keeping promises made.

Findings noted in Part II research suggest that the use of collaborative planning methodologies in carrying out construction projects is perceived by project participants to have affected collaborative relationships between the main contractor and the subcontractors. Research thus supports the relationship suggested by the literature review, that

Y is related to Z

This means that in order to accomplish various types of project outcome (Y), it is vital to address how collaboration may be developed and sustained (Z), and to learn about the barriers to collaboration as well as the social conditions under which collaboration is to take place.

In part II of the DBA programme the research question posed was:

"How can collaborative progression planning tools be used to increase the degree of collaboration in construction projects in Norway?"

Based on findings in Part II, it may be suggested that degrees of a) familiarity and common goal setting, b) involvement and communications, c) conflict (trust), d) motivation, e) awareness of each other's perspectives and, f) predictable working processes all may be positively affected by structural, organisational, behavioural and attitudinal measures.

Data is based on two construction cases alone, and thus is too limited to generalise to the whole population of Norwegian construction projects. However, the research offers valuable insight into *how* planning methodologies may be implemented and utilised to improve main contractor subcontractor relationships in Norway. As such, the case study approach offers valuable contributions to the understanding of collaborative processes beyond the mere vindication of a functional relationship between use of progression planning tools and main contractor subcontractor relationships in Norway.

5.4 Part III

5.4.1 Introduction Part III

In this part of the research a survey was carried out with the aim to test statistically the functional relationship between the use of progression planning tools and the development of main contractor subcontractor relationships in Norway. 12 construction projects were selected from two different construction companies. The 12 projects were selected by the management in the two companies. Some criteria were forwarded to the management to guide the selection of construction projects.

The projects needed to

- be defined as a collaborative planning project
- be in a building phase with the most possible amount of subcontractors and own employees present
- have a project manager who was positive to the survey and thus could motivate participation

In addition the researcher pointed out that projects of a certain size would be preferable but not necessary, and last, no geographical considerations needed to be taken.

About the projects

The 12 construction projects represented in the survey differed on various characteristics. Five projects were new apartment buildings, five were new commercial buildings, and one was a combination of new apartment building and new commercial building. One project was a combination of rehabilitation and new commercial building.

Type of project	Number
New Apartment Buildings	5
New Commercial Buildings	5
New Apartment Buildings /Commercial	1
Rehabilitation/new commercial building	1
Total	12

Table 5.12 Distribution of survey projects according to type.
Source: author.

The construction projects lasted between 10 and 48 months. There was a large geographical spread of the projects, from the south-east coast to the south-west coast, and north to the middle of Norway. Project monetary size varied from 30 to 900 million NOK. The gross size of the buildings ranged from 5300 to 125000 m2. All 12 construction projects were conducted as turnkey projects in which the main contractor had full responsibility towards the builder. In nine of the projects the share of own production was less than 50 percent. In two projects the share of own production was larger than 50 percent and in one the share was about 50 percent.

5.4.2 Data collection and analysis Part III

Research questions and hypothesis

In part III the research hypothesis raised aimed at statistically answering the main research question:

> *"Can collaborative progression planning tools be used to increase the degree of collaboration in construction projects in Norway?"*

Research objectives were to study the relationship between use of progression planning tools and six set of dimensions of collaborative relationships in construction projects. The objectives are referred to in section 3.6.2, on page 65.

Data collection Part III

Data collection process

Data collection took place over a period of six months, from March 2012 to September 2012. Data was collected by researcher visits to the construction sites. Prior to the visits, consent was secured with the project management. Upon notification from the two companies from which the construction projects were selected, and that project managers had accepted and welcomed the survey to take place on their sites, an e-mail was sent to each, describing the intention with the survey and clarifying expectations concerning the implementation of the survey. Project management was asked to forward information received to subcontractor project managers or officers involved in their project, with a request that they too informed their employees on the project about the upcoming researcher visit and survey. Approximately one week prior to the visits, a reminder was sent to the project management, this time a simplified version of the information sent previously was attached to make the information available to the workers in the lunch rooms.

Upon arrival to the sites, the researcher was met by the project management representative who offered coffee and later led the way to the lunch facilities. Beforehand, it was clarified that all project participants, who found their way to the lunch facilities, on the particular day of the visit, constituted the gross sample of respondents to be approached. A total of 514 respondents were approached and asked to take part in the survey. All had been notified in the written information provided that participation was voluntary and anonymous. Out of the 514 approached, 485 accepted to take part in the survey (net sample). 29 chose not to participate. Out of the 29 who chose not to participate, six refused on the grounds that they had just joined the project and were unable to answer. Although the survey had been translated into English, five out of the 29 refused because of language barriers. 18 refused without stating any reasons. This gives a response rate of 94.4 percent.

While on the sites, on many instances the researcher enjoyed the privilege of guided tours on the site, and participating in lookahead meetings. Often, the project management set a side much time for conversation and took interest in the survey.

Most visits were arranged to take place on the same day as lookahead meetings to enable contact with subcontractor management. The meeting participants were asked to spend the first part of the meeting answering the survey questionnaire. Everyone approach with a question to participate in the survey, did participate.

Survey questionnaire

The pen and paper based survey questionnaire was pilot tested and modified prior to the main study. The questionnaire consisted of three parts. The first part was comprised of background information about the respondents. Part two was comprised of questions concerning various collaborative planning activities they had been involved in. The last part consisted of 15 statements which were responded to in terms of disagreeing or agreeing on a scale (Likert, 1932) from 1, totally disagree, to 5, totally agree. A 'not sure' category was also provided, (see appendix F, on page 238).

The questionnaires took an average of approximately 10 minutes to answer, with some finishing in eight minutes, while a few others took up to 15 minutes. Time spent to respond was not recorded for each respondent.

5.4.3 Part one of the survey

Part one of the survey addressed background variables of the respondents.

About the respondents

Out of the 12 construction projects in the survey, seven were selected from case study company A, and five from case study company B. Subcontractors participated in the survey. A total of 85 companies were represented, two main contractors and 83 subcontractors. Table 5.13 shows the distribution of respondents per project.

	Frequency	Valid Percent	Cum. percent
1	37	7.6	7.6
2	49	10.1	17.7
3	40	8.2	26.0
4	27	5.6	31.5
5	36	7.4	39.0
6	33	6.8	45.8
7	28	5.8	51.5
8	32	6.6	58.1
9	43	8.9	67.0
10	23	4.7	71.8
11	101	20.8	92.6
12	36	7.4	100.0
Total	485	100.0	

Table 5.13 Distribution of respondents per construction project. (n=485).
Source: author.

There was a total of 485 respondents (n=485) in the survey, and a large spread in respondents per project. The average number of respondents per project was 40. 20.8 percent of the respondents (n=101) represented the construction project with the largest number of respondents. 4.7 percent of the respondents (n=23) represented the construction project with the smallest number of respondents.

The median value (the middle number resulting in half the numbers having values greater than the median, and half the numbers having values less than the median) was calculated to be 36.

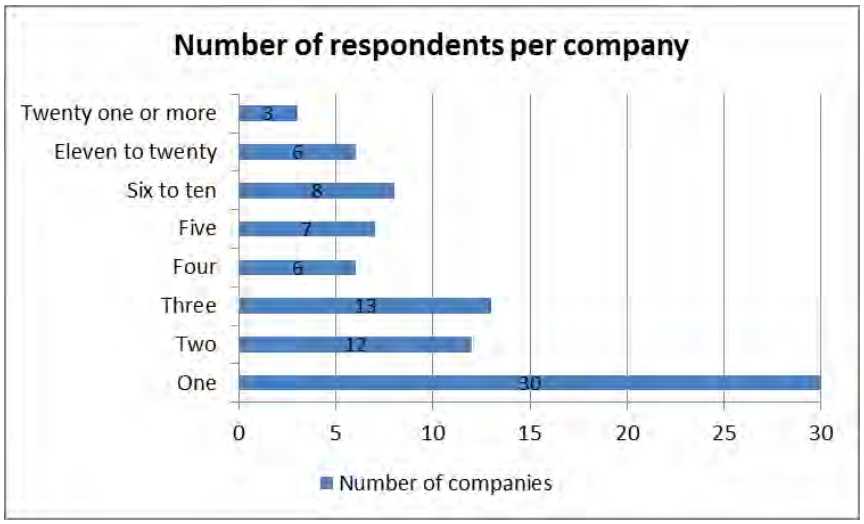

Figure 5.3. Number of respondents per company.
Source: author.

Figure 5.3 shows the spread of respondents on the 85 (sub-) construction companies taking part in the survey. Figure 5.3 shows that 30 companies were represented by one respondent, 12 companies were represented by two respondents, 13 companies were represented by three respondents, 6 companies were represented by four respondents, 7 companies were represented by five respondents, 8 companies were represented by six to ten respondents, 6 companies were represented by eleven to twenty respondents, and lastly, 3 companies were represented by twenty one or more respondents, including the two main contracting companies accounting for 39 and 119 respectively.

The average number of respondents per company was 6, the median value was 3 and the mode value was 1. Table 5.14 shows the distribution of respondents in terms of main contractor or subcontractor affiliation.

Main contractor/Subcontractor				
	Frequency	Percent	Valid Percent	Cumulative Percent
subcontractor	327	67.4	67.4	67.4
main contrac-tor	158	32.6	32.6	100.0
Total	485	100.0	100.0	

Table 5.14. Distribution of main contractor and subcontractor respondents. (n=485).
Source: author.

Respondent positions

Respondents were asked to tick one of 10 alternative positions held in that particular project. An 'other' alternative was provided with the option of stating position. The 10 alternatives were recoded into three. A qualitative assessment of the stated position in 'other' was carried out and 36 respondents (other) were recoded into 'management level' or 'worker level'. Respondent positions were recoded into a) workers, b) team supervisors, and c) project management.

Table 5.15 shows the frequency and percentage of respondents who fall under each of the three categories of positions. Workers constituted the largest group with 338 respondents, or 70.0 percent of the respondents. Team supervisors accounted for 10.4 percent and project management for 19.7 percent.

Position-categorised					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Workers	338	69.7	70.0	70.0
	Team supervisors	50	10.3	10.4	80.3
	Project management	95	19.6	19.7	100.0
	Total	483	99.6	100.0	
Missing	System	2	.4		
Total		485	100.0		

Table 5.15. Distribution of respondents according to position categories (n=485).

Source: author.

Respondents age

The age of the respondents ranged from 15 years to 72 years and were categorised as shown in table 5.16.

Age-categorised					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	24 years or younger	151	31.1	31.5	31.5
	25 - 34 years	120	24.7	25.1	56.6
	35 - 44 years	92	19.0	19.2	75.8
	45 - 54 years	74	15.3	15.4	91.2
	55 - 64 years	38	7.8	7.9	99.2
	65 years or older	4	.8	.8	100.0
	Total	479	98.8	100.0	
Missing	System	6	1.2		
Total		485	100.0		

Table 5.16. Respondents age categorised (n=485).

Source: author.

The highest represented age group of respondents was 24 years or younger. In this group 94 percent were categorised as workers. There was a significant correlation between age and position. The degree of management position is increasing with age.

Formal education

Formal education was recoded into five categories. Figure 5.4 shows that nearly half of the respondents have senior high school with certificate, whereas only 5.4 percent finished elementary school as their highest formal education.

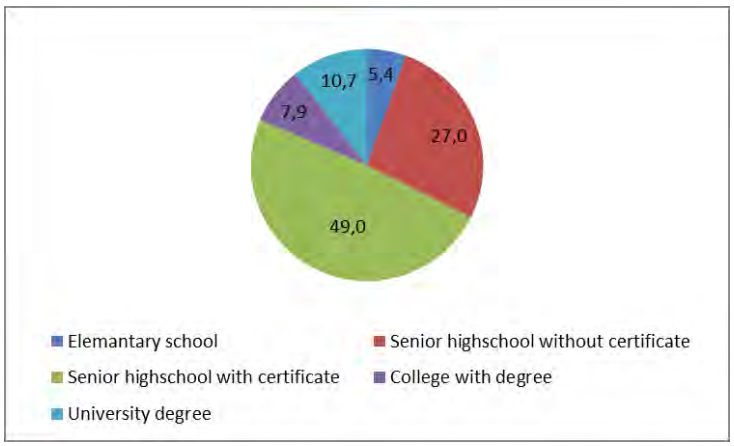

Figure 5.4. Distribution formal education.

Source: author.

Number of years with current employer

Figure 5.5 displays the percentage of respondents by number of years with their current employer. Data shows an equal distribution of the categories.

Figure 5.5. Distribution number of years with current employer

Source: author.

Company size

Figure 5.6 shows that more than half of the respondents work for companies with more than 100 employees. The number of respondents who work for companies that employ 5-25 and 26-100 is equally distributed.

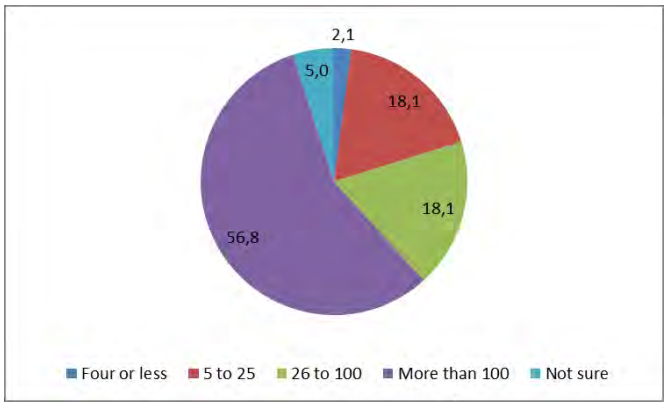

Figure 5.6. Distribution of respondents by company size.

Source: author.

Experiences with collaborative planning methodologies

65.8 percent of the respondents claimed not to have been involved in previous construction projects in which collaborative planning was used, whereas 34.2 percent had been involved in projects with collaborative planning. 8.5 percent of the respondents did not respond to this question.

5.4.4 Part two of the survey

The second part of the survey was comprised of questions concerning various collaborative planning activities they had been involved in. The selection of questions asked was based on previous researcher experience with collaborative planning implementation processes and management literature on Lean Construction.

Participation in meetings and discussions

Table 5.17 displays a summary of participation in preparing various level plans. Data shows that 44.2 percent of the respondents noted that they had participated in kick-off meetings. 46.7 percent had not participated, and 9.1 percent were either not sure or found the question not applicable to them. A cross tabulation of the recoded variable

position and participation in kick-off meetings showed that out of 210 respondents who participated in kick-off meetings, 47.6 percent were workers, 14.3 percent were team supervisors and 38.1 percent were project management.

Participated	Respondents	Yes	No	Not sure/not applicable	Total
Kick-off meeting	all	44.2	46.7	9.1	100
Planning post-it-notes	all	23.7	67.8	8.5	100
Main progress plan	management	76.7	17.4	5.8	100
Phase plan	Supervisors and management	70.0	25.7	4.3	100
Lookahead plan	Supervisors and management	52.1	37.3	10.5	100
Weekly plan	Supervisors and management	68.1	25.5	6.4	100
Team plan	workers, supervi-sors and foremen	32.1	55.1	12.9	100

Table 5.17. Percentage of participation in preparing different levels of plans (n=485).
Source: author.

Nearly one in four of the respondents noted that they had participated in process planning sessions with post-it-notes. Two out of three respondents had not participated, and 8.5 percent were either not sure or found the question not applicable to them. More than three out of four of the project management noted that they had participated in preparing a main progress plan. 17.4 percent had not participated, and 5.8 percent were either not sure or found the question not applicable to them.

70.0 percent of supervisors and management noted that they had participated in preparing a phase plan. One out of four had not participated. 4.3 percent were either not sure or found the question not applicable to them.

Approximately half of the supervisors and management noted that they had participated in preparing a lookahead plan. 37.3 percent had not participated. 10.5 percent were either not sure or found the question not applicable to them.

More than a third of the supervisors and management noted that they had participated in preparing a weekly plan. 25.5 percent had not participated. 6.4 percent were either not sure or found the question not applicable to them.

Close to a third of the workers, supervisors and foremen noted that they had participated in preparing a weekly team plan. 55.1 percent had not participated. 12.9 percent were either not sure or found the question not applicable to them.

Involved in discussions concerning production

Table 5.18 shows the percentage distribution of respondents who attended meetings where 'healthy' activities were used, and where obstacles to future production or previous production tasks were discussed.

	Did attend	Did not attend	Not sure	Not applicable	Total
Attend meetings where 'healthy activities' is used	22.5	60.8	14.1	2.5	100
Attend meetings discuss obstacle future production	52.7	39.3	6.1	1.9	100
Attend meetings discuss obstacles previous tasks	46.3	42.5	8.3	2.9	100

Table 5.18. Attending meetings to discuss premises for production.
Source: author.

22.5 percent of the respondents noted that they had attended meetings where 'healthy activities' was used. 60.8 percent had not attended such meetings, and 14.1 percent were not sure. 52.7 percent of the respondents noted that they had attended meetings where they discussed obstacles for future production. 39.3 percent had not attended such meetings, and 6.1 percent were not sure. 46.3 percent of the respondents noted that they had attended meetings where they discussed obstacles to previous tasks. 42.5 percent had not attended such meetings, and 8.3 percent were not sure.

69.0 percent of the respondents answered that they did acquire useful knowledge from discussing and removing obstacles. 12.4 percent did not acquire useful knowledge, and 15.2 percent were not sure. 3.4 percent answered that the question were not applicable. 2.3 percent did not answer this question, giving an n=474.

Shared construction site facilities

Approximately half of the team supervisors and project management reported that they shared office space on the construction site with participants on the same management level. 2.2 percent found the question not applicable to them. When the question was asked whether the team supervisors and project management would like to share space on the construction site with participants on the same management level, 51.6 percent reported that they would like to. 30.5 reported that they would not like to share offices, whereas 18.0 percent found the question not applicable to them, or they were not sure.

75.3 percent of the respondents answered that contractors shared the same lunch facilities in the project. 15.3 percent of the respondents answered that contractors did not

share the same lunch facilities in the project. 9.4 percent were not sure, or found the question not applicable to them.

27.7 percent of the respondents reported that managers and workers share the same lunch facilities in the project. 57.4 percent of the respondents reported that managers and workers did not share the same lunch facilities, and 14.9 percent were not sure or found the question not applicable to them.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Never participated	155	45.9	52.9	52.9
	Participated 1 -3 times	118	34.9	40.3	93.2
	Participated 4 or 5 times	12	3.6	4.1	97.3
	Participated 6 times or more	8	2.4	2.7	100.0
	Total	293	86.7	100.0	
Missing	System	45	13.3		
Total		338	100.0		

Table 5.19. Percentage of respondents who had participated in joint social events (n=338).
Source: author.

45.0 percent of the respondents indicated that they had never participated in joint social events in the project. 44.3 percent indicated that they had participated one – three times, 6.8 percent had participated four or five times, and 4.0 percent of the respondents indicated that they had participated six times or more in joint social events in the project.

When investigating the workers only, 52.9 percent had never participated, 40.3 percent had participated one to three times, 4.1 percent had participated four or five times and 2.7 percent had participated six times or more.

Among the group of team supervisors, 34.8 percent had never participated, 54.3 percent had participated one to three times, 6.5 percent had participated four or five times and 4.3 percent had participated six times or more.

In the group of project management, 24.7 percent reported that they had never participated, 52.8 percent had participated one to three times, 15.7 percent had participated four or five times and 6.7 percent had participated six times or more.

Sense of appreciation

Table 5.20 shows the percentage distribution of perceived appreciation of the work performed. 79.2 percent of the respondents reported that they felt that their immediate superiors appreciated the job they were doing in the project. 4.1 percent reported that they

did not feel that the immediate superiors appreciated the job they were doing, whereas 15.2 percent were not sure.

	Yes	No	Not sure	Not applicable	Total	n
Do you feel that your immediate superiors appreciate the job you are doing	79.2	4.1	15.2	1.5	100	466
Do you feel that the project management appreciates the job you are doing	58.2	10.1	29.6	2.1	100	467
Do you feel that the other contractors appreciate the job you are doing	50.4	8.1	39.7	1.7	100	468

Table 5.20. Percentage distribution of the perceived appreciation of work performed.
Source: author.

Table 5.20 shows that 58.2 percent of the respondents reported that they felt that the project management appreciated the job they were doing in the project. 8.1 percent reported that they did not feel that the project management appreciated the job they were doing, whereas 29.6 percent were not sure. Approximately half of the respondents reported that they felt that the other contractors appreciated the job they were doing in the project. 8.1 percent did not feel that the other contractors appreciated the job they were doing, whereas 39.7 percent were not sure.

17.8 percent of the respondents indicated that they had experienced an unnecessary separation between the contractors in the project. 60.2 percent indicated that they had not experienced an unnecessary separation between the contractors. 21.2 percent of the respondents were not sure.

5.4.5 Part three of the survey

In part three of the survey, respondents was asked to respond to how much they agreed to statements on a scale of one to five. A 'not sure' category was provided. The selection of statements was based on the literature review and pilot study outcome. In this section, responses to statements are accounted for, before the data analysis process is presented.

Responses to statements

Table 5.21 shows an overview of the total responses to the 15 statements included in the survey questionnaire.

	Statements	Either totally disagreed or disagreed to some extent	Neither disagreed nor agreed	Either totally agreed or agreed to some extent	Not sure	Total
1	contributes to contractors working as one team	7.2	21.7	60.2	10.9	100
2	influences contractors to increasingly work towards a common goal	5.7	15.0	67.8	11.6	100
3	contributes to closer dialogue between contractors	5.3	22.0	59.6	13.1	100
4	enables me to be more involved in the construction	9.0	22.9	57.0	11.1	100
5	helps us to jointly solve problems at an early stage	9.8	20.8	58.6	10.8	100
6	contributes to fewer conflicts and blaming/criticism among contractors	8.3	22.2	55.9	13.6	100
7	contributes to increased job satisfaction	4.9	21.2	63.1	10.8	100
8	makes me commit to take more responsibility in the project	6.1	22.0	60.6	11.2	100
9	makes me more interested in other trades' work	11.4	24.1	53.1	11.4	100
10	positively affects contractors to offer a helping hand and to share resources	10.6	26.3	51.6	11,5	100
11	positively affects the perceived equality among contractors	4.3	26.8	55.1	13.8	100
12	gives me greater confidence that promises made by other trades are kept	6.3	28.8	51.4	13.5	100
13	contributes to more structured meetings	5.5	29.8	46.6	18.1	100
14	contributes to a tidier and more organised site	4.9	19.7	65.3	10.1	100
15	makes me focus more on improvement and learning	5.5	20.9	62.2	11.4	100

Table 5.21. Overview of responses to survey statements (n=485).

Source: author.

On average 7.0 percent of the respondents either totally disagreed or disagreed to some extent with the statements provided. The average percentage of respondents who neither disagreed nor agreed was 19.0 percent. On average 57.9 percent of the respondents either totally agreed or agreed to some extent with the statements, and lastly, on average 12.2 percent was not sure. The statement 'makes me more interested in other trades' work' received the highest average percentage of respondents who either totally disagreed or disagreed to some extent with the statement. The statement 'positively affects

the perceived equality among contractors' received the lowest average percentage of respondents who either totally disagreed or disagreed to some extent with the statement.

The statement 'influences contractors to increasingly work towards a common goal' received the highest average percentage of respondents who either totally agreed or agreed to some extent with the statement. The statement 'contributes to more structured meetings' received the lowest average percentage of respondents who either totally agreed or agreed to some extent with the statement.

The mode value of the respondents, who neither disagreed nor agreed, was 22, close to the average of 22.95. The range of average values for 'neither disagreed nor agreed' was 15.0 to 29.8.

The statements were qualitatively sorted under the set of six indicators/dimensions presented in section 3.6.1. In the following, dimensions comprising the factor statements will be accounted for.

Operational hypothesis

Operational hypotheses were developed to test the significance of the effect of using progression planning tools on six set of indexed dimensions of collaborative relationships in construction projects. The six indices were constructed by two or three statements for each index, i.e. each index consisted of two or three indicators; statements which were responded to by ticking an option on a scale from totally disagree to totally agree with the statement. The indicators were added together to form each index, and each indicator carried equal weights. For example, index one (operational hypothesis 1 below), contained two indicators, each framed as statements. Each of the statements counted for 50% of the index. Index four (operational hypothesis 4 below), contained three indicators, each carrying one third of the total weight of the index. The six dimensions listed on page 64 thus accounts for the dependent variables which were tested in the study, i.e., the effect on each of the six dimensions, or dependent variables, of the three sets of independent variables contained in the survey. The output regression models are contained in appendix G, on page 244 onward.

Operational hypothesis 1

The first operational hypothesis to be tested was:

H1: The use of progression planning tools has a positive effect on the degree of familiarity and common goal setting in the construction project.

With the zero hypothesis:

H0: The use of progression planning tools has no effect on the degree of familiarity and common goal setting in the construction project.

The first index, degree of familiarity and common goal setting, contained two indicators, a) 'contributes to contractors working as one team' and b) 'influences contractors to increasingly work towards a common goal'. The statements were framed as follows:

"In this project, I find that collaborative planning contributes to contractors working as one team"

"In this project, I find that collaborative planning influences contractors to increasingly work towards a common goal"

Each respondent was asked to give an answer on a five-point scale ranging from 1, totally disagree, to 5, totally agree.

Regression analysis was conducted with the following results:

Regression model, degree of familiarity and common goal setting

The regression model for the degree of familiarity and common goal setting, see appendix table 8, shows that the contractor affiliation had a strong and positive effect on the degree of familiarity and common goal setting close to the significance level of five percent. Project participants working for the main contractors seemed more positive than subcontractor employees. Position 'foremen' had a negative and significant effect on the degree of familiarity and common goal setting, indicating that, although overall positive, they were less positive than workers, who accounted for the reference group. Age had a significant negative effect on the degree of familiarity and common goal setting, indicating that as age increases, the probability of responding positively on the two statements which forms the basis for the index, decreases. Both high school with and without certificate had a positive effect on the degree of familiarity and common goal setting within the significance level, indicating that these employees were more positive to the degree of familiarity and common goal setting than those who had finished ele-

mentary school as their highest formal education. Company size also was close to the significance level, for the 'four or less' category.

Overall, the regression model shows that participation in planning meetings and collaborative discussions had positive effects on the dependent variable, all other variables held at zero. However, in terms of participation, two variables had a significant (or close to) effect on the dependent variable. One was participation in developing a phase plan (.054) and the other was discussing obstacles to previous tasks, with the latter having a negative effect.

In terms of relational aspects, shared lunch facilities between workers and managers, and perception of appreciation by other contractors had a significant and positive effect on the degree of familiarity and common goal setting, while experience of us and them had a significant and negative effect. The latter indicates that as the tendency to answer 'yes' increases, the probability of responding positively to the two statements, which forms the basis for the index, decreases.

The adjusted R2 for the regression model, degree of familiarity and common goal setting, was .217, which means that 21.7 percent of the variability in the dependent variable was accounted for by the independent variables. This must be said to be fairly high in survey data analysis, and the standardised coefficients (BETA) showed that the most important explanatory variables were high school with and without certificate, participating in developing a phase plan and experiencing us and them. (The BETA coefficients are reported on page 251 in appendix I). High school with certificate was the most important explanatory variable when explaining the degree of familiarity and common goal setting in constructions projects.

Operational hypothesis 2

The second operational hypothesis to be tested was:

H1: The use of progression planning tools has a positive effect on the degree of involvement and communications in the construction project.

With the zero hypothesis:

H0: The use of progression planning tools has no effect on the degree of involvement and communications in the construction project.

The second index, degree of involvement and communications, contained two indicators, a) contributes to closer dialogue between contractors, b) enables me to be more involved in the construction process. The statements were framed as follows:

"In this project, I find that collaborative planning contributes to closer dialogue between contractors"

"In this project, I find that collaborative planning enables me to be more involved in the construction process"

Regression analysis was conducted with the following results:

Regression model, degree of involvement and communications

Table 9 in the appendix section shows the regression model output. None of the background variables had a significant or even close to significant effect on the degree of involvement and communications, nor did the participation variables. The output related to the relational aspects show that two variables were found to have significant and negative effect on the degree of involvement and communications. One was participation in joint social events 6 times or more, and the other was experienced us and them. The variable managers and workers share lunch facilities had a positive effect on the degree of involvement and communications, and was close to the significance level (.070). The explanatory power (R2) of the model was .212, or 21.2 percent of the variability in the dependent variable was accounted for by the independent variables.

The standardised coefficients (BETA) showed that the most important explanatory variables were position management, participating in developing of phase plan, high school with certificate, participation six times or more in social events, and experiencing us and them. Position management was the most important explanatory variable when explaining the degree of involvement and communications in constructions projects.

Operational hypothesis 3

The third operational hypothesis to be tested was:

H1: The use of progression planning tools has a positive effect on the degree of conflict (trust) in the construction project.

With the zero hypothesis:

H0: The use of progression planning tools has no effect on the degree of conflict (trust) in the construction project.

The third index, degree of conflict (trust), contained two indicators, a) helps us to jointly solve problems at an early stage, b) contributes to fewer conflicts and blaming/criticism among contractors. The statements were framed as follows:

"In this project, I find that collaborative planning helps us to jointly solve problems at an early stage"

"In this project, I find that collaborative planning contributes to fewer conflicts and blaming/criticism among contractors"

Regression analysis was conducted with the following results:

Regression model, degree of conflict (trust)

The regression model output, see appendix table 10, shows that the only background variable found to have an effect on the degree of conflict (trust) was formal education, category 'high school with certificate' (.020).

Participation in developing a phase plan had a positive effect on the degree of conflict (trust) well within the significance level of five percent.

In terms of the relational aspects, the variable managers and workers share lunch facilities had a positive effect on the degree of conflict (trust), and well within the significance level (.005). The variable experienced us and them had a significant negative effect on the degree of conflict (trust). The explanatory power of this model was .179, or 17.9 percent of the variability in the dependent variable being accounted for by the independent variables.

The standardised coefficients (BETA) showed that the most important explanatory variables were high school with certificate, participating in developing of phase plan, managers and workers share lunch facilities, position management and high school without certificate. High school with certificate was the most important explanatory variable when explaining the degree of conflict (trust) in constructions projects.

Operational hypothesis 4

The fourth operational hypothesis to be tested was:

H1: The use of progression planning tools has a positive effect on the degree of motivation in the construction project.

With the zero hypothesis:

H0: The use of progression planning tools has no effect on the degree of motivation in the construction project.

The fourth index, degree of motivation, contained three indicators, a) contributes to increased job satisfaction, b) makes me commit to take more responsibility in the project and c) makes me focus more on improvement and learning. The statements were framed as follows:

"In this project, I find that collaborative planning contributes to increased job satisfaction"

"In this project, I find that collaborative planning makes me commit to take more responsibility in the project"

"In this project, I find that collaborative planning makes me focus more on improvement and learning"

Regression analysis was conducted with the following results:

Regression model, degree of motivation

The regression model, see appendix table 11, shows that the variable years with company, '2 – 4 years', was close to the significance level, showing a negative effect on the degree of motivation.

Overall, participation variables had a positive effect on the degree of motivation, however, none within the significance level.

In terms of the relational variables, perceived job appreciation, the category by project management, had a positive effect on the degree of motivation within the five percent confidence level. The adjusted R2 for the model was .089, indicating a somewhat

weaker explanatory power of the model, compared to the other analysis, but at a normal level for survey data analysis.

The standardised coefficients (BETA) showed that the most important explanatory variables were high school with and without certificate, discussing obstacles to future production, two to four years employment and being appreciated by project management. High school with certificate was the most important explanatory variable when explaining the degree of motivation in constructions projects.

Operational hypothesis 5

The fifth operational hypothesis to be tested was:

H1: The use of progression planning tools has a positive effect on the degree of awareness of each other's perspectives in the construction project.

With the zero hypothesis:

H0: The use of progression planning tools has no effect on the degree of awareness of each other's perspectives in the construction project.

The fifth index, degree of awareness of each other's perspectives, contained three indicators, a) makes me more interested in other trades' work processes, b) positively affects contractors to offer a helping hand and to share resources, and c) positively affects the perceived equality among contractors. The statements were framed as follows:

"In this project, I find that collaborative planning makes me more interested in other trades' work processes"

"In this project, I find that collaborative planning positively affects contractors to offer a helping hand and to share resources"

"In this project, I find that collaborative planning positively affects the perceived equality among contractors"

Regression analysis was conducted with the following results:

Regression model, degree of awareness of each other's perspectives

The regression model output is shown in appendix table 12. In this model, age had a negative and close to significant effect on the degree of awareness of each other's perspectives. Formal education category high school without certificate had a positive effect on the degree of awareness of each other's perspectives, close to the significance level (.067) and company size, 'twenty six to one hundred', had a negative effect on the degree of awareness of each other's perspectives, also close to the significance level (.052).

In terms of participation variables, the variable discussing healthy activities had a positive effect on the degree of awareness of each other's perspectives, close to the five percent level of significance (.067).

The following relational variables had significant positive effects on the degree of awareness of each other's perspectives; perception of job appreciation both 'by project management' (.011), and 'by other contractors' (.011). The variable experienced us and them, had a significant negative effect on the degree of awareness of each other's perspectives. The adjusted R2 for the model was .134, again indicating a somewhat weaker explanatory power of the model, compared to the other analysis, but at a normal level for survey data analysis.

The standardised coefficients (BETA) showed that the most important explanatory variables were high school without certificate, being appreciated by project management, high school with certificate, being appreciated by other contractors, and experiencing 'us' and 'them'. High school without certificate was the most important explanatory variable when explaining the degree of awareness of each other's perspectives in constructions projects.

Operational hypothesis 6

The sixth operational hypothesis to be tested was:

H1: The use of progression planning tools has a positive effect on the degree of predictable working processes in the construction project.

With the zero hypothesis:

H0: The use of progression planning tools has no effect on the degree of predictable working processes in the construction project.

The sixth index, degree of predictable working processes, contained three indicators, a) gives me greater confidence that promises made by other trades are kept, b) contributes to more structured meetings, and c) contributes to a tidier and more organised site. The statements were framed as follows:

"In this project, I find that collaborative planning gives me greater confidence that promises made by other trades are kept"

"In this project, I find that collaborative planning contributes to more structured meetings"

"In this project, I find that collaborative planning contributes to a tidier and more organised site"

Regression analysis was conducted with the following results:

Regression model, degree of predictable working processes

The regression model output, see appendix table 13, shows that years with company had a significant effect on the degree of predictable working processes. Both '2 – 4 years', and '5 – 11 years', had a significant and negative effect on the degree of predictable working processes, indicating that those who had been with the company for less than two years were more positive.

In terms of the participation variables, discussing healthy activities had a significant positive effect on the degree of predictable working processes (.042). Participating in developing a lookahead plan had a positive effect on the degree of predictable working processes, although only close to the significance level (.071). Participating in developing a main progress plan had a significant negative effect on the degree of predictable working processes, indicating that those who did not participate in this activity gave more positive responses.

Relational variables show that there were significant positive effects on the degree of predictable working processes. Contractors sharing lunch facilities had a significant positive effect on the degree of predictable working processes (.039), as did perception of job appreciation by 'project management' (.001). The variable experienced us and

them had a significant negative effect on the degree of predictable working processes (.004). The adjusted R2 for the model was .144.

The standardised coefficients (BETA) showed that the most important explanatory variables were being appreciated by project management, participating in developing a main progress plan, high school with certificate, two to four year employment, and experiencing us and them. Being appreciated by project management was the most important explanatory variable when explaining the degree of predictable working processes in constructions projects.

Regression summary and discussion

Overall, the regression model outputs showed that participation both in developing various levels progression plans and in discussing production related issues predicted positive scores on the dependent variables. In this research, a five point scale used was used, from totally disagree, disagree to some extent, and to totally agree on the other end of the scale. This means that even if respondents had given a score of disagree to some extent, they still indicated some positivity towards the dependent variable, or index. The *constant* in the regression model represent the rough location on the scale, if all independent variables had values of zero. This indicates that as more independent variables are inserted into the model, more variables are taken into the account to affect the constant.

In the following discussion, the research hypotheses are discussed in relations to the regression model output.

1) There is a positive functional relationship between the use of progression planning tools and the degree of familiarity and common goal setting in the construction project.

Although all participation variables showed some positivity towards the dependent variable, participating in developing a phase plan seemed to have a strong and close to significant effect on the degree of familiarity and common goal setting. Interview data suggested that kick-off seminars in particular included phase schedule planning activities, involving subcontractors and lower management levels within the main contractors. Informants who were involved in these sessions reported that the joint phase

schedule planning session stimulated participants to familiarise with trades' needs and inter-trade dependencies. Also, some kick-off sessions facilitated written collaborative agreements, stating how to best collaborate to achieve production efficiency.

Discussing obstacles to previous production had a negative significant effect. This result agrees with observation and interview data which showed that too much focus on reasons for progression behind schedule was counterproductive in terms of stimulating to familiarity and common goal setting. Relational aspects had an effect on the degree of familiarity and common goal setting in the construction project. In projects in which managers and workers had the opportunity to share lunch facilities, this reportedly constituted an arena for project participants to socialise and to familiarise themselves with each other. Also, when informants perceived that other contractors appreciated the job they were doing, this had a positive effect on the degree of familiarity and common goal setting. Observation data suggested that when project management facilitated involvement and close dialogue, feedback on other trades' impact on own production occurred, and some meeting chairs were observed to give more positive feedback to subcontractors than others. Some meeting chairs were observed to demonstrate equal expectations from own trades as from subcontractors, which was observed to have a dampening effect on the feeling of 'us' and 'them'.

Based on the regression model results the hypothesis

There is a positive functional relationship between the use of progression planning tools and the degree of familiarity and common goal setting in the construction project

is partially supported.

2) There is a positive functional relationship between the use of progression planning tools and the degree of involvement and communications in the construction project.

Overall, all participation variables seemed to have positive scores on the dependent variable degree of involvement and communications, and no single participant variable seemed to stand out as having stronger and significant effect on the dependent variable degree of involvement and communications. Progression planning meetings were ob-

served to vary on a number of dimensions, see section 6.5.3. In the more effective meetings, involvement of subcontractors enabled discussions and decisions to be made concerning interdependent tasks, and meeting chairs were observed to stimulate communication to various degrees, some motivating a two-way constructive communication more than others.

Facilitating shared lunch facilities between managers and workers seemed to stimulate involvement and communication, and participant behaviour which resulted in a dampening effect on the feeling of 'us' and 'them' was found to contribute positively towards the degree of involvement and communications in the construction project.

Based on the regression model results the hypothesis

There is a positive functional relationship between the use of progression planning tools and the degree of involvement and communications in the construction project

is partially supported.

3) There is a negative functional relationship between the use of progression planning tools and the degree of conflict in the construction project.

Participating in developing progression plans predicted positive scores on the dependent variables, although again, participating in developing a phase schedule plan was stronger and significantly positive. Again, interview data suggested that being involved in planning for the construction phase ahead had a dampening effect on conflicts. In these planning sessions, decisions were enabled at an early stage, so that contractors could plan their resource input and make sure everything was thought of in terms of task dependencies and finding the correct order of activities to avoid collisions, errors and rework.

Observation data showed that when meeting chairs managed to actively motivate and stimulate discussions to solve issues at an early stage, before they evolved into problems, this had a dampening effect on levels of conflicts, and helped build trust. Also for this dependent variable, managers and workers sharing lunch facilities, and participant behaviour that had a dampening effect on the feeling of 'us' and 'them' was found to contribute positively towards the degree of conflict in the construction project.

Based on the regression model results the hypothesis

There is a negative functional relationship between the use of progression planning tools and the degree of conflict in the construction project

is partially supported.

4) There is a positive functional relationship between the use of progression planning tools and the degree of motivation in the construction project.

Overall all participation variables seemed to have positive scores on the dependent variable degree of motivation, and no single variable seemed to stand out as having a stronger and significant effect on the dependent variable degree of motivation. From observations, it was evident that management had a crucial role in encouraging motivational aspect of collaboration among the group of project participants. This ability was performed to various degrees, some meeting chairs being able to affect motivational levels more than others, by encouraging and inviting active involvement and facilitating team-building, and by stimulating trust-building communication and inspiring commitment.

In interviews, workers reported that active engagement in meetings was a motivation factor. This finding supports the finding that perceived job appreciation by project management had a strong and positive effect on the degree of motivation in the construction project.

Based on the regression model results the hypothesis

There is a positive functional relationship between the use of progression planning tools and the degree of motivation in the construction project

is partially supported.

5) There is a positive functional relationship between the use of progression planning tools and the degree of awareness of each other's perspectives in the construction project.

Overall all participation variables seemed to affect the scores positively on the dependent variable degree of awareness of each other's perspectives, and no single variable seemed to stand out as having a stronger and significant effect on the dependent variable degree of awareness of each other's perspectives. Observation data suggested that meetings, in which there was a systematic focus on discussions concerning dependencies and order of activities, proved more effective in terms of stimulating awareness of each other's perspectives. Increased awareness reportedly resulted in increased levels of respect for finished products. All arenas for progression planning reportedly provided an arena for such awareness to increase.

Noted benefits from kick-off seminars were increased generosity and participants becoming more attentive towards each other, and an increased awareness of dependencies. Discussions of interdependence were observed to take place in kick-off seminars, and progression planning meetings, although to various degrees.

It seemed that when project participants were involved in effective discussions about progression planning, they gave and received feedback on how they were performing according to plans. This type of conversation seemed to affect participants' perception of job appreciation by others. Perceived job appreciation by project management and by other contractors had a strong and positive effect on the dependent variable degree of awareness of each other's perspectives in the construction project.

Based on the regression model results the hypothesis

There is a positive functional relationship between the use of progression planning tools and the degree of awareness of each other's perspectives in the construction project

is partially supported.

6) There is a positive functional relationship between the use of progression planning tools and the degree of predictable working processes in the construction project.

Participating in developing progression plans predicted positive scores on the dependent variable degree of predictable working processes, although, participating in developing a lookahead plan was stronger and significantly positive. Observation in lookahead meetings showed that to varying degrees, managers were able to focus discussions on

removing obstacles to future activities, or to discuss and create healthy activities. Managers, who effectively focused on involving all participants, stimulating an open dialogue, and discussing activities within a manageable timeframe, 5 – 9 weeks ahead, were able to create more predictable workflow to a larger extent than those who did not. Some managers were observed to be more concerned with analysing reasons for plan deviance in lookahead meetings, causing some frustration among participants. For the most part, lookahead meetings reportedly resulted in open dialogue and improved relationships between contractors, and increased work process predictability by discussing concerns and removing obstacles to future production.

Interview data supported the finding that contractors sharing lunch facilities had a significant and positive effect on the degree of predictable working processes.

Based on the regression model results the hypothesis

There is a positive functional relationship between the use of progression planning tools and the degree of predictable working processes in the construction project.

is partially supported.

From the above summary, it is clear that both participation in progression planning meetings and relational aspects positively affected the six dependent variables, although not all significantly. Overall, in terms of background variables, none of these seemed to have strong and positive impacts on the models. An exception was formal education, which in some instances seemed to have an effect on the model dependent variable, indicating that participants with high school to a certain degree were more positive than those with elementary school as their highest formal education.

Chapter 6 Results

6.1 Introduction

In this chapter, the combined results of Parts I, II and III research are discussed in terms of the research question

"Can collaborative progression planning tools be used to increase the degree of collaboration in construction projects in Norway?"

The three separate research parts were designed to address the main research question from different perspectives. Further, each part addressed conclusions from the synthesised literature review, which showed that relationships exist between X, Y and Z, (see page 55).

In the following sections results from each of the three research parts will be discussed in terms of the relationships suggested above. Further, the combined results will be discussed in terms of the six dimensions which have been used to operationalise the concept of collaborative relationship in this thesis.

6.2 Part I research

Part I research was accounted for in chapter 5.2, starting on page 83. The study aimed at describing Norwegian project managers' and foremen's experienced effects of collaborative planning, using the Last Planner System as a systematic framework for planning purposes. The study explored five main issues: a) information and support received; b) elements of collaborative planning used; c) effects and outcomes experienced; d) particular challenges faced; and, e) drivers for future use of the methodology. Conclusions included:

a) Information about various types of project support was received concerning Lean Construction/collaborative planning. Practical information seemed to increase understanding of the methodology to a larger extent than theoretical information.

b) Collaborative planning activities were mainly comprised of kick-off meetings, some with phase schedule planning; regular meetings adapted to proper planning horizons, and shared office facilities.

c) Positive effects and outcomes were reported from implementing collaborative planning methodologies in construction projects.

d) Challenges were faced in terms of adaptation to longer planning horizons, transition to new meeting structures and letting go of a traditional approach to planning (see page 3). Other noted challenges were involvement and relational issues.

e) Crucial drivers for future use of the methodology were key personnel to direct development processes; top management engagement; practical and theoretical knowledge of collaborative planning; and project support.

The study described experiences made by actors in a project based production setting, a type of joint interaction (X) that was established to achieve a specific type of outcome, i.e. construction project delivery (Y). Hence, the relationship between X and Y, as suggested in the literature synthesis on page 55 onward, also existed in current research. Informants, main contractor project managers and foremen, shared their experiences of implementing collaborative planning methodologies to improve project performance, both in terms of qualitative, non-measurable outcomes and effects, and effects that project managers and foremen may achieve on the project level.

In terms of the hypothesis put forward in chapter 5.2.2, on page 84, that

The company has benefited from implementing collaborative work practices associated with Lean Construction and the Last Planner System in their projects

it was concluded that the hypothesis was strengthened, that there is a functional relationship between the use of Last Planner System as a collaborative working methodolo-

gy and project managers' and foremen's experiences with conducting construction projects, as well as effects experienced in the form of project delivery.

Besides describing effects and outcomes experienced by the informants, the study also revealed important aspects of implementing such methodologies. Knowledge of support functions, barriers and key drivers may help future practitioners to adopt a holistic approach to similar development processes.

6.3 Part II research

Part II research was accounted for in chapter 5.3, starting on page 106. The aim of the case study project was to explore *how* collaborative progression planning processes may help develop collaboration within Norwegian construction projects. Two construction projects acted as the basis for the study, in which both interviews and observations were conducted. Conclusions from this study were made that:

a) Progression planning tools *may* influence the degree of familiarity and common goal setting by establishing arenas for and stimulating interaction.

b) Progression planning tools *may* influence the degree of involvement and communications by inviting participation and stimulating communication.

c) Progression planning tools *may* influence the degree of conflict by focusing communication on early solutions and problem solving.

d) Progression planning tools *may* influence the degree of motivation by encouraging and inviting active involvement; facilitation of team-building; stimulating trust-building communication; and inspiring commitment.

e) Progression planning tools *may* influence the degree of awareness of each other's perspectives by focusing discussions and conversations on relations and dependencies.

f) Progression planning tools *may* influence the degree of predictable working processes by facilitating communication concerning production preconditions and stimulating commitment.

The study described collaborative activities in which the case study projects engaged, as well as showing how relational processes within the framework of the collaborative planning methodology unfolded. As such, the study addressed the need emphasised by previous authors (Egan, 1998) to focus on collaboration in achieving various types of project outcome. Thus, the study comprised actors who aimed at improving production planning and control (Y), by involving subcontractors to take part in joint collaborative planning activities (Z). The relationship between Y and Z, was accounted for as suggested by literature on page 57.

In terms of the research question put forward in chapter 5.3.2, on page 109, to study

"How can collaborative progression planning tools be used to increase the degree of collaboration in construction projects in Norway?"

it was concluded that; a) degrees of familiarity and common goal setting; b) involvement and communications; c) conflict (trust); d) motivation; e) awareness of each other's perspectives; and f) predictable working processes all *may* be positively affected by structural, organisational, behavioural and attitudinal measures.

The case study shows that when conducting construction projects, collaborative planning methodologies may be useful in developing main contractor subcontractor collaborative relationships. However, the data also evidenced the need to ensure that relational considerations are taken into account. This suggests that structures and procedures alone may not improve collaborative relationships, but may constitute a foundation on which interpersonal and relational aspects of collaboration may prosper.

6.4 Part III research

Part III research was accounted for in chapter 5.4, starting on page 133. The study aimed at statistically testing the functional relationship between the use of progression planning tools and collaborative relationships between main contractors and subcontractors in Norwegian construction projects. Conclusions were made that:

a) The use of progression planning tools has a positive effect on the degree of familiarity and common goal setting in the construction project.

Was partially supported

b) The use of progression planning tools has a positive effect on the degree of involvement and communications in the construction project.
Was partially supported

c) The use of progression planning tools has a positive effect on the degree of conflict (trust) in the construction project.
Was partially supported

d) The use of progression planning tools has a positive effect on the degree of motivation in the construction project.
Was partially supported

e) The use of progression planning tools has a positive effect on the degree of awareness of each other's perspectives in the construction project.
Was partially supported

f) The use of progression planning tools has a positive effect on the degree of predictable working processes in the construction project.
Was partially supported

Besides background variables, the survey was comprised of independent variables concerning participation in collaborative progression planning activities; participation in discussions concerning production preconditions; sharing facilities; and a sense of appreciation. The dependent variables comprised 15 statements factored into six dimensions, or indexes of collaboration. Hence the quantitative study captured actors involved in a project based production setting, a type of joint interaction (X) and their experiences with improved collaborative culture (Z). As such, the relationship between X and Z, as suggested in the literature synthesis, starting on page 71, existed in current research. Project participants; both from main contractors and subcontractors, and on all project levels, responded to the survey, offering valuable insight into effects on collaborative relationships of being involved in construction projects based on collaborative planning methodologies.

In terms of the hypotheses put forward in chapter 5.4.2, on page 134, it was concluded that hypotheses concerning the following relationships were partially supported: the use of progression planning tools has a positive effect on the degree of familiarity and common goal setting; degree of involvement and communications; the degree of conflict (trust); degree of motivation; the degree of awareness of each other's perspectives; and the degree of predictable working processes in construction.

6.5 Six dimensions of collaboration

In this section the combined results are discussed in light of the six dimensions (indexes) of collaborative relationships, on page 64. First, discussion focus on implications for practice, and second, theoretical implications and considerations of the results are accounted for.

6.5.1 Implications for practice

Egan (1998) and other authors concluded that relationships within the construction industry need to be improved (see page 16). Collaborative progression planning methodologies, based on or inspired by the Last Planner System (described in detail in chapter 2.4.6, on page 46), have over the last two decades been implemented, adapted and modified attempting to increase production control by involving more actors in planning than in traditional construction projects. Although the ambition has been to improve production and planning control, an implicit element of such an approach was assumed to have been to invite closer collaborative relationships with key actors in the value chain. The scope of the current research has been to study collaborative relationships between the main contractor and subcontractors on the building site. The construction projects represented in this research have to varying degrees, with varying experiences of previous attempts, and varying levels of motivation, implemented collaborative progression planning methodologies in their projects. Previous research (Jørgensen et al., 2004) indicates that collaborative relationships between contractors has improved as a result of using LPS, and the survey carried out in current research partially support a functional relationship between the use of progression planning tools and main contractor subcontractor collaborative relationships. There may be several explanations for this. Firstly, as indicated by case study data (part I and II), relationships, particularly on the team supervisor and worker level, were largely perceived to be adequate even without the new collaborative approach to planning. Secondly, many workers and even

some team supervisors were not much involved, and even related the methodology to activities in which foremen and project managers were engaged. Third, survey data only captured which activities respondents participated in, and thus provide no insight into how the progression planning activities were carried out. Case study interviews and observation data offer insight into the processes of implementing and using progression planning tools. Based on the combined results of the three separate parts in the current research, it is argued that if the ambition is to improve production control by implementing collaborative planning methodologies, both structural and relational considerations need to be accounted for. This means that providing a meeting structure and establishing systems and routines to approach progression planning is important, but nevertheless not enough to ensure goal attainment. Project managers need also to focus attention on the uses of tools, the processes involved and especially the people and their relationships. Implementing collaborative planning methodologies thus may present far greater challenges beyond setting up progression planning structures and routines, and following guidelines for LPS implementation. Hence, attention must be paid to 'what to do' and 'how to do it'.

In the following, the six dimensions of collaboration used in this research are discussed in terms of the combined results.

Degree of familiarity and common goal setting

The analysis found partial significant evidence to statistically support the hypothesis that the use of progression planning tools has a positive effect on the degree of familiarity and common goal setting (research objective on page 65) in the construction project. However, case study analysis concluded that progression planning tools *may* influence the degree of familiarity and common goal setting by establishing arenas for participants to familiarise with the construction project and each other. This may indicate that although kick-off seminars are arranged, and meeting structures are established, based on, or inspired by the collaborative planning methodology, this in itself is not enough to affect the degree of familiarity and common goal setting. Case study data suggested that in the early phases of the construction project, management may facilitate and stimulate development of familiarity and common goal setting firstly by establishing a common platform of integrated knowledge and information. This may be done in early kick-off seminars where information is presented concerning project and builders' expectations, and participants also informing each other about their needs and ex-

pectations, thus sharing trade knowledge and expertise with the group. A worker expressed his experience of participating in a kick-off seminar as follows:

"Earlier you were never introduced to anything, you only knew that something was to be built, that's it. Knowing a bit more about how things will be, is very positive."

Developing personal relationships built on trust and confidence is also of importance in the start-up phase. By facilitating room and time for social small-talk and interaction over time, participants may get to really know each other, and develop group chemistry. Participants may get to know each other as well as receiving knowledge of each other's roles in the project. By presenting themselves to each other, a sense of being seen and heard is nurtured. Management may provide room and time for participants to have conversations and to listen to each other, thereby stimulating confidence-building behaviour.

Objectives and goals were developed (see page 115), based on local and global needs and knowledge. This entailed project participants working in groups to establish common goals, which may trigger a sense of cohesiveness, and a sense of knowing that your input is important. By discussing common objectives for a collaborative process, issues that are important to the project and to all participants may be considered. Also, by discussing how to meet project objectives, participants may reconcile own goals with project goals, by sharing knowledge which the project may benefit from. When participants together develop joint actions plans, an opportunity is created to emphasise what is important to each of them. This may stimulate a sense of cohesiveness and motivate ownership of the project. Further, developing a joint progression plan based on actor input and shared trade knowledge, may positively affect the degree of familiarity and common goal setting. This was done by the involvement of all key participants in developing a phase schedule plan. In this way participants contributed to a joint progression plan, rather than having a super planner tell them when to do what. By discussing inter-trade dependencies, participants learned from each other and felt they were being heard regarding their own dependencies to other trades. Paying attention to each other's needs in planning, created a sense of equality, and a sense of being important. This interaction created possibilities for increased awareness.

"Already at the kick-off you have to think about the people around you, when you place the post-it-notes. I think much of the foundation is laid here"

Also, by discussing the right order of activities, optimal production processes could be obtained based on discussions and exchanged knowledge. Lastly, the case study findings demonstrated the need to establish guidelines in terms of who, what, when and how to conduct phase schedule planning, by taking into consideration timing of the kick-off seminar, whom to involve and whom not to involve, which phase to plan for, and to make certain the plan developed collaboratively is followed up afterwards.

Degree of involvement and communications

Although the hypothesis was only partially supported, that the use of progression planning tools had a positive effect on the degree of involvement and communications (research objective on page 65) in the construction project, progression planning tools *may* still influence the degree of involvement and communications by inviting project participants into meetings, and in meetings exhibited a behaviour which stimulates engagement and communication. Again, the combined results from the survey and the case study suggest that an important lesson can be learned from how involvement is taking place, and how meeting participants communicate to really feel involved in communication concerning progression planning. On the one hand, involvement and communications have structural and systematic elements, which include preparation for meeting behaviour, establishing a systematic meeting structure, developing communicative tools such as Excel and Microsoft Project, and making decisions concerning who should be involved, when and how. On the other hand, involvement and communications have relational elements, including participants' communicative behaviour, interactive behaviour, management motivated communication and the focus of communication.

Degree of conflict (trust)

Analysis showed a partial support for the contention that use of progression planning tools has a positive effect on the degree of conflict (trust) (research objective on page 65) in the construction project. This conclusion agrees with conclusions from the case study project, that progression planning tools *may* influence the degree of conflict by focusing communication in meetings on finding mutual solutions, and to attend to matters at an earliest possible time, so that matters are solved before evolving into problems. In phase schedule planning sessions, some participants were involved in joint planning of the next construction phase. However, a question arose concerning whom to involve in such planning sessions. As stated above, case study data demonstrated a focus of communication on production issues, which to a large extent concerned a con-

stant discussion of sequences and dependencies between activities, finding solutions at an early stage, and removing obstacles to production. Such communicative and interactive behaviour thus may help build trust between the participants.

Degree of motivation

The hypothesis, that the use of progression planning tools has a positive effect on the degree of motivation (research objective on page 65) in the construction project was partially supported. At the same time, case study data suggest that progression planning tools *may* influence the degree of motivation by involving and stimulating to a sense of team atmosphere. By making and keeping promises (see pages 28 and 125), trust levels may increase, and so may motivation to engage and commit to project collaboration and outcome. Motivation is seen as a dimension of collaboration in current research, as motivation to commit may be reflected in collaborative behaviour. This entails committing to keeping plans, or to getting involved and engaged in meeting discussions, as well as a general motivation for collaborative work. Also, as stated in part I research, motivation increased from learning and understanding collaborative processes and inter-trade dependencies. Motivation was also gained from enjoying increased respect and understanding from project participants. Lastly, the degree of motivation may increase as a result of perceived better control of progress.

Degree of awareness of each other's perspectives

The hypothesis that the use of progression planning tools has a positive effect on the degree of awareness of each other's perspectives (research objective on page 65) in the construction project was partially statistically supported. However, both part I and part II interview data suggest that progression planning tools *may* influence the degree of awareness of each other's perspectives by focusing discussions and conversations on relations between participating contractors, and dependencies between project activities. Interactivity of conversation and discussion about the needs of each trade regarding their production process, and the dependencies between activities and trades, started already in the start-up phase. In particular, phase schedule planning sessions seemed to motivate engagement in such questions. In case A, a group of project participants spent much time, away from daily operations, to discuss what each of them wanted and needed in terms of achieving optimal work flow. Work flow as a term is continually debated within the Lean Construction academic community. To date, no one definition seems to be agreed upon of the term construction work flow. In this research, thus, work flow

refers to the general personal perception of production free of stops and interruptions. The group also agreed on ways to accommodate total project work flow. Hence, awareness of each other's perspectives was not only a matter of being self-centred on one's own needs, but how to achieve optimal work conditions on the project level, by taking into account the trade level. The mere act of such conversations was reported to constitute new experiences to some project manager level participants, who reportedly were more familiar with a one-way focus on main contractor needs and perspectives. As part I and II data suggest, discussions and conversations concerning participating contractors' relations and project activity dependencies to a greater or lesser extent were repeated in various level progression planning meetings. Not all managed to achieve the full potential of engaging participants in conversations. The lack of such engagement and involvement in discussions and conversations thus may impede the possibility of an increased awareness of others' perspectives. Again, data suggest that of greater importance than the actual setting up of kick-off seminars and progressions planning meetings is how conversational behaviour is facilitated and motivated throughout the project lifetime.

Degree of predictable working processes

Analysis demonstrated a partial support for the contention that use of progression planning tools has a positive effect on the degree of predictable working processes (research objective on page 65) in the construction project. The conclusion agrees with conclusions from the case study projects on page 132, that progression planning tools *may* influence the degree of predictable working processes by continuously addressing possible obstacles to future tasks, and stimulating the commitment to keeping promises made. According to data, in general, having predictable working processes is a prevalent expression of a well-functioning collaborative relationship. The extent to which work processes are predictable was a concern on all project levels, and when asked to describe project collaboration, examples and stories often concerned this particular dimension. The survey concluded that participation in discussing healthy activities and in developing lookahead plans had a significant or close to significant positive effect on the degree of predictable working processes. Case study data suggest there was a main focus on removing obstacles to future production. However, statements also indicated that the matter of discussing preconditions and removing obstacles was approached differently. Some meeting chairs established a routine of a somewhat mechanical manner of reporting whether preconditions were met, (yes and no to seven preconditions), oth-

ers invited to a more open discussion, still focusing on project activities in a systematic manner. In terms of the degree of predictable working processes as a dimension of collaborative relationships, those who participated in discussions seemed more enthusiastic about the predictability of working processes. An obvious explanation may be that discussions involving more than one trade stimulate more information sharing than if a meeting chair only relates to one participant at a time to update the progress status on possible obstacles to production. Meeting chairs evidently had an important role in stimulating conversations to remove obstacles by continuously asking questions and confirming that information given was received and understood by other participants.

The above discussion shows that construction practitioners, who aim to improve collaborative relationships with their subcontractors, by implementing collaborative progressions planning methodologies, need to consider both structural aspects, such as adapting purposeful routines and procedures on the one hand, and relational aspects, such as interaction and interpersonal behaviour on the other hand. Table 6.1 below summarises the two aspects in terms of the six dimensions of collaborative relationships and demonstrates the equal importance of both aspects.

Degree of	Structure, routines and procedures	Examples, by/such as	Relational aspects, interaction, interpersonal behaviour	Examples, by/such as
Familiarity and common goal setting	Establish collaborative arenas, involve subcontractors, establish procedures for meetings	Kick-off seminars, regular progression planning meetings, shared facilities, use of agenda, develop and adapt communicative tools	Establish a platform of integrated knowledge and information, develop group chemistry and trigger cohesiveness, motivate ownerships, create sense of equality, facilitate learning communicate meeting purposes	Share information on project goals, clarify stakeholder expectations, inform each other of needs, share trade knowledge and expertise, work together to set goals, encourage social talk, motivate talking and listening, motivate two-way communication stressing importance of all input
Involvement and communications	Involve subcontractors, establish a systematic meeting structure, use of different time perspectives, use of communicative tools	Progression planning meetings, management closer to production plan for production closer in time, use of e.g. Excel/Microsoft project	Stimulate engagement and communication, ensure focused conversations of perceived importance, stimulate participant behaviour, motivate interactive/communicative behaviour	Ensure all are heard and provided time to talk uninterrupted, express expectations of meeting behaviour, focus communication on what is perceived important, two-way communication, active listening, ask clarifying questions, small motivational comments, express promises
Conflict (trust)	Invite early participation, facilitate arenas for conversations and discussion, facilitate social talk and familiarising	Kick-off seminars, involve in joint planning next construction phase, progression planning meetings, with appropriate time perspective	focus communication on finding mutual solutions early, e.g. phase schedule planning sessions, involve and engage participants in discussions and planning, stimulate group discussion	Attend to matters at an earliest appropriate time, discuss order of activities and dependencies, focus on removing obstacles to production, make and keep promises, ask questions and make comments, urge group to find joint solutions
Motivation	Involve participants in project activities, facilitate arenas for making commitment	Kick-off seminars and regular progression planning meetings, discuss plans and preconditions	Stimulate making and keeping promises, stimulate learning and understanding of collaborative processes and inter-trade dependencies, stimulate increased respect and understanding better control of progress	Stimulate to a sense of team atmosphere learning motivate involvement and engagement in meeting discussions
Awareness of each other's perspectives	Facilitate kick-off seminars, phase schedule planning sessions, regular meetings	Repeat in various level progression planning meetings	Get to know each other, focus discussions and conversations on relations between participating contractors and dependencies between project activities	Conversation and discussion about own and project production processes and needs, tow-way communications, motivate and facilitate conversational behaviour throughout
Predictable working processes	Establish arenas to discuss production issues	Kick-off seminars with phase schedule planning, progression planning meetings	Main focus on removing obstacles, Participate in discussing healthy activities, stimulate commitment	Continuously ask questions and clarify that information given is received and understood, make and keep promises

Table 6.1. Structural and relational aspects in developing collaborative relationships.
Source: author.

6.5.2 Barriers to developing collaborative relationships using progression planning tools

An aim of this research was to study relational development processes with the use of collaborative progression planning tools. Both parts I and II of the current research revealed that there are potential barriers to developing collaborative relationships between main contractors and subcontractors. Barriers to collaboration were also discussed on page 23 in the literature review. Barriers noted in current research may be described according to structural and relational barriers.

Structural implementation barriers

Structural issues when implementing collaborative progression planning methodologies may constitute barriers to developing main contractor subcontractor relationships when the credibility of the methodology is threatened. One is semi solutions, caused by decisions, such as, e.g. double-versions (traditional and collaborative approaches), light versions (selective involvement or activities), or caused by nature of project production, e.g. overlap of current and new construction projects. Another barrier is lack of management capability to manage in accordance with methodology guidelines, e.g. in terms of division of planning, division of time perspectives, and to develop and use communicative planning tools. A third structural barrier is design decisions, which may jeopardise reliability of plans and prevent planning involvement. Although not much attention has been given to the effect of piece rate work on collaborative relationship in this research, interview data shows a tendency to support literature (Kaka et al., 2008).

Relational barriers

Relational issues when implementing collaborative progression planning methodologies may constitute barriers to developing main contractor subcontractor relationships when the trust and confidentiality between actors are threatened. As noted earlier, communication in progression planning meetings to a large extent was about expressing promises to follow up plan or agreements. Increased tendencies to fail to comply with promises may negatively affect trust levels. Another issue concerning communication was the actual use of language. A self-centred approach to communication may foster perceptions of inferiority and inequality, resulting in self-protective behaviour and less willingness to commit to plans or to real involvement. Such situations may be reinforced by management behaviour, if what is preached is not practiced. Further, ambiguous use of language may create uncertainty among the participating group, which again may affect the level of trust. Another component which may cause barriers to collaboration

is perceived and experienced differences in access to information. Data suggest that lack of management capability to conduct meetings in a purposeful, involving manner, may also create barriers to collaboration.

As addressed earlier, structural and relational elements are intertwined and interdependent elements of developing collaborative main contractor subcontractor relationships. This assertion holds true also as regards potential barriers to improved relationships, as structural barriers affect relational issues and vice versa. Table 6.1, on page 173, summarises the structural and relational aspects that need to be taken into account to affect various dimensions of collaboration.

6.5.3 Implications for theory

For the purpose of presenting the data, an ethnographic approach (Van Maanen, 1979) was used. Figure 6.1, first column, depicts informant behaviour descriptions, and researcher observations. In other words, these are facts, or first order themes. The words, expressions and literary pictures used by informants to describe situations, opinions and processes, provided the basis for interpretation into second order concepts (second column). The analysis process was characterised by going back and forth between interview transcripts and observation protocols until higher abstraction levels were reached. Second-order concepts were thus researcher interpretations of the first-order themes. In other words, these were attempts to theorise about the facts, by organising and explaining the facts as given or observed. Theorising entails inferences about assumptions underlying facts given or observed (Van Maanen, 1979). Similar approaches to presenting data structure has been made (Colman, 2008) borrowing from ethnographic studies. Third order dimensions of the use of progression planning tools were then derived from second order concepts, as shown in figure 6.1 (third column).

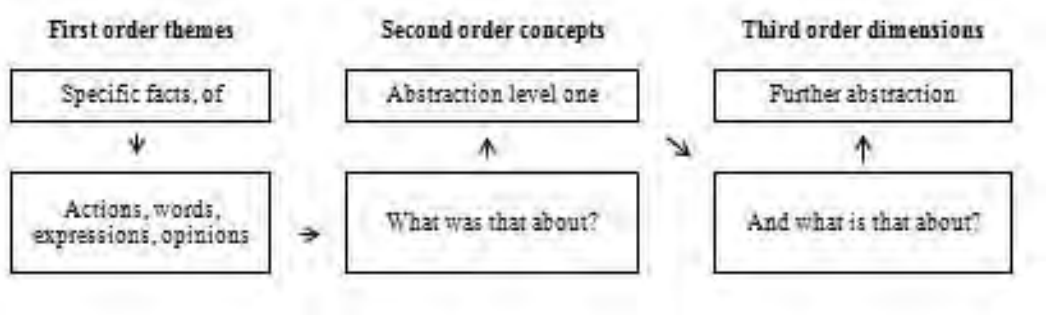

Figure 6.1. Data structure template.

Source: author.

Data was organised according to a) a structural dimension of the use of progression planning tools, and b) a relational dimension of the use of progression planning tools. Figure 6.2 present concepts derived from data regarding *structural* aspects.

The established guidelines for meeting preparation and behaviour varied in the data, from clear and unambiguously expressed expectations articulated early in the start-up phase, or even in written subcontracts, one the one end of the spectrum, to none at all on the other end. Statements by main contractors and subcontractors indicated that:

- clearly established guidelines positively affected relationships
- systematic meeting structure and implementation were of variable quality
- meetings were performed with variable rigidity

Data support the assertion that within the practice of (a basically similar) collaborative planning methodology, differences existed in terms of:

- types of meetings held
- regularity
- who participated
- how meetings were systematically linked
- use of agenda
- performed achievement of purpose

However, differences in themselves need not be negative; on the contrary; differences in the use of progression planning tools indicate adaptation to the uniqueness of the project. Rather, data suggest that the robustness and thoroughness of the use of progression planning tools seem more important.

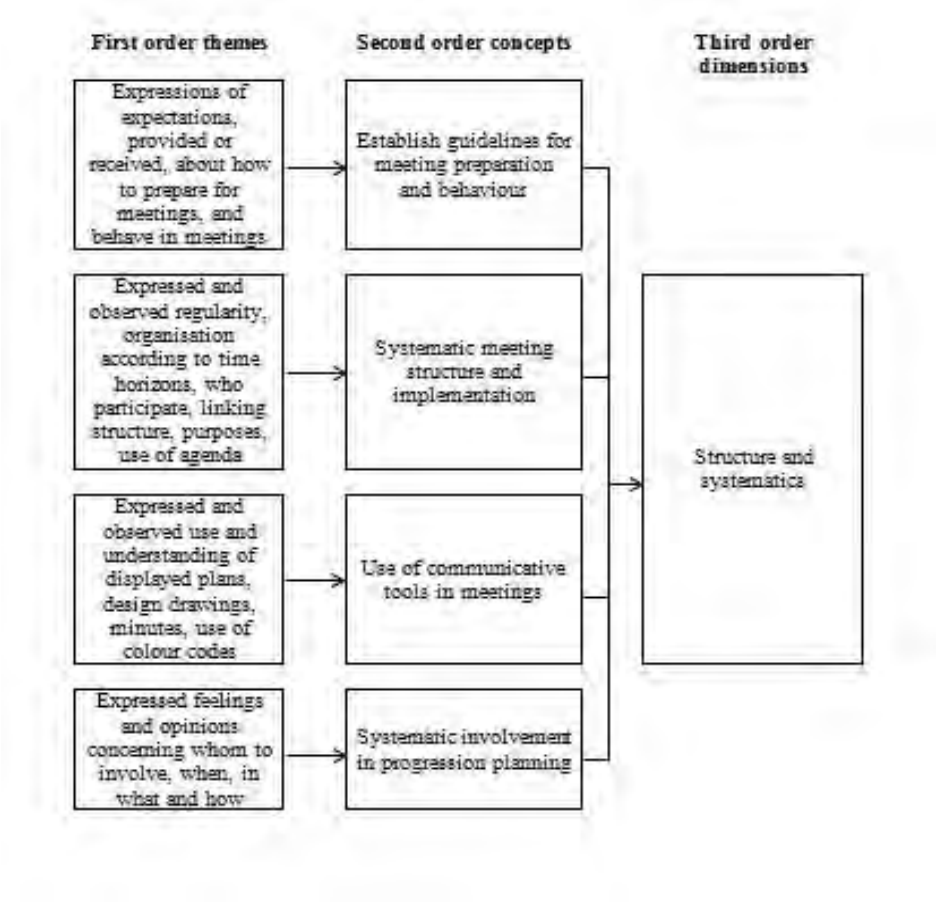

Figure 6.2. Themes and concepts underlying the structural dimension.

Source: author.

Use of communicative tools in meetings seems to be an important element in establishing collaboration among project participants. Plans need to be communicated so that participants understand

- which activities to be carried out
- when
- where
- by whom
- which activities have dependencies to other trades' activities

This entails requirements for the preparation of a planning tool, such as Excel or Microsoft Project. Other than being read and understood, planning tools also provided a basis for communication, i.e. was a communicative tool. Plan design, structure and complexity varied in terms of:

- use of colour codes
- logical structures (according to building, floor, activity etc.)
- complexity
    - number of activities
    - information per activity
    - time perspective
    - visibility of dependencies

Some informants expressed frustration over not understanding plans presented, which also affected their ability to engage in discussions, and contribute with their knowledge and information.

Systematic involvement in progression planning is a key concept in understanding the structure and systematics of uses of progression planning tools. Again, the qualitative data showed differences, both in terms of:

- who were involved (main contractor)
- which subcontractors were involved
    - all
    - technical trades
- worker involvement

There were also variations in terms of what participants were involved in, such as:

- kick-off seminars
- phase schedule planning
- regular progression planning meetings

Decisions concerning levels of involvement seemed to have an effect on the perceived collaboration. Informants, who were involved early, and in activities perceived to be important to their own progress control, tended to express greater satisfaction with the overall collaboration, than informants who to a lesser extent felt they were involved. There was also noted a generally widespread desire among informants to be involved in the construction process.

The second order concepts derived from the data were further abstracted to form a higher level of abstracted category, or, a third order dimension. The third order dimension referred to structures and systematics of the use of progression planning tools.

Figure 6.3 presents concepts derived from data regarding *relational* aspects. The communicative behaviour as observed in meetings, or described by informants in interviews, varied both between and within cases, from the very active and engaged meeting participants, to the reserved and quiet ones. It may be asserted that levels of commitment and information sharing may affect the overall level and content of communicative behaviour. This assertion was supported in interviews.

Communicative behaviour is linked to the concept of interactive behaviour, in that the way participants relate to each other in progression planning settings may inhibit or stimulate engagement levels and communicative behaviour. For instance showing respect by:

- letting other participants speak uninterrupted
- use of eye-contact in conversations
- actively showing interest and raising concerns
- two-way communication

In some instances communication flowed between several participants, in other instances communication seemed to be restricted to taking place between the meeting chair and one participant at the time.

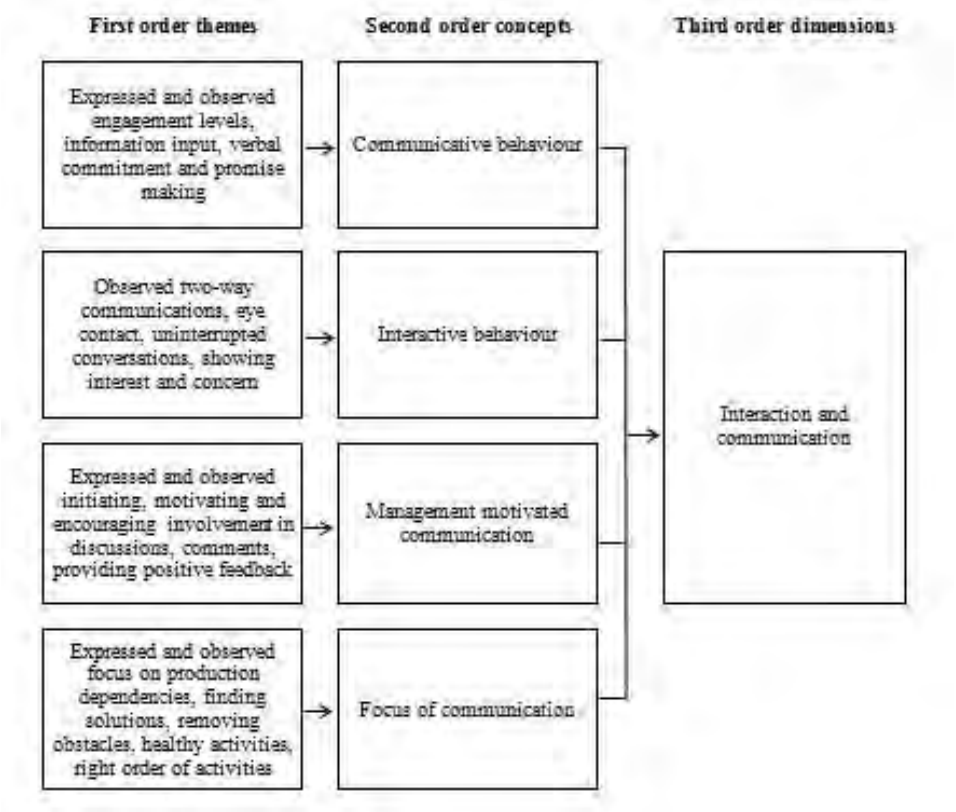

Figure 6.3. Themes and concepts underlying the relational dimension.

Source: author.

Based on findings it may be asserted that the management role in stimulating communicative and interactive behaviour is evident and strong. Both interview and observation data suggest that the level of communicative behaviour and interactive behaviour was strongly connected to management's ability to initiate, motivate and encourage involvement in discussions and conversations. Mostly, such management stimuli were reflected in:

- asking questions
- clarifying issues
- making comments
- providing feedback
- inviting fellow participants to likewise behaviour

The level of participation in communication was observed to be higher when meeting chairs managed to affect communicative and interactive behaviour. This shows that while involvement is a matter of decisions concerning whom to involve, in what, and

when, etc., that is, a systematic and structural approach to involvement, there is also a relational sense to the term involvement, in which data suggest management behaviour is crucial.

An important concept derived from the first order themes was focus of communication in the use of progression planning tools. Observations in general demonstrated an overall attention to production progression planning issues, with a focus on:

- finding mutual solutions
- optimal order of activities
- removing obstacles
- discussing activity dependencies

While an overall attention to these matters was observed, differences were noted, e.g. in terms of planning time horizons used, emphasis on start or end dates, etc. Variations also existed concerning inclusion of HSE and quality issues into progression planning meetings. Survey findings also stated a significant effect of participation in discussing healthy activities on the degree of predictable working processes. The second order concepts derived from the data were further abstracted to form a higher level of abstracted category, or, a third order dimension. The third order dimension referred to interaction and communication in the use of progression planning tools.

Third order dimensions of the use of progression planning tools

Findings in this research indicate that attempts to use progression planning tools in developing collaborative main contractor subcontractor relationships in Norwegian construction projects, need to incorporate both structural and relational dimensions in order to optimise relational effects. Although the main aim of the construction projects represented in this data may not have been to improve main contractor subcontractor relationships per se, an assumption was made, that in order to improve production control by involving more project participants into progression planning routines and procedures, an implicit ambition was that relationships would be affected. Data indicate that variations existed both in establishing structures and a systematic approach to the use of progression planning tools on the one hand, and likewise variations in terms of relational aspects of the use of progression planning tools on the other hand. Based on the findings, an assertion may be made that both dimensions are of equal importance, and that the two dimensions may reinforce each other. Figure 6.4 shows the relationship be-

tween the two third order dimensions derived from the second order concepts. The figure emphasises that use of progression planning tools should focus on both dimensions in an interplay to affect relationships. Structural dimensions may create a foundation for interaction and communication, and relational dimensions may serve to exploit or take advantage of the opportunities for collaboration that lie in the collaborative structures.

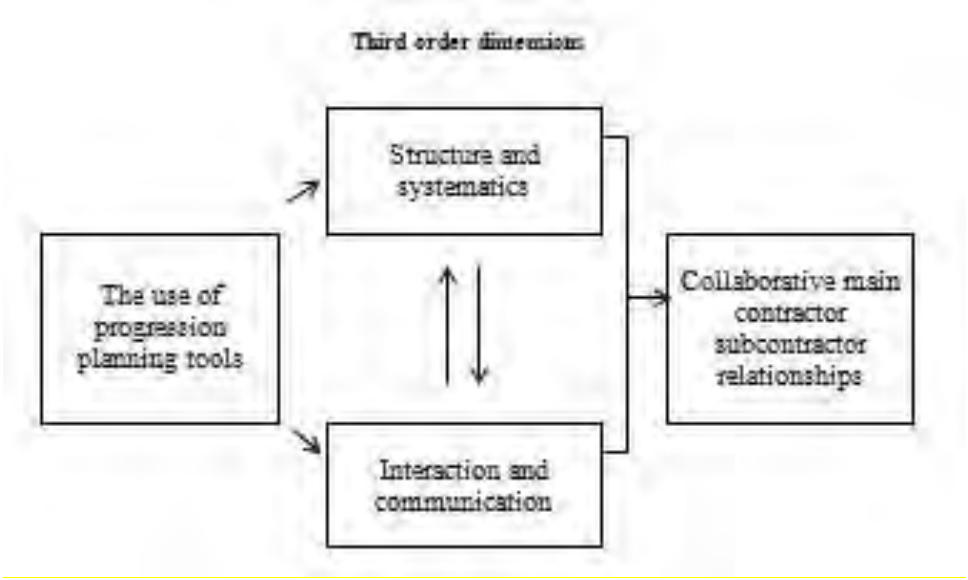

Figure 6.4. Interplay between third order dimensions to affect relationships.
Source: author.

Previous research (Andersen et al., 2008) has pointed out the need to take into account 'the social system of construction', in addition to the understanding of production as a physical and logistical process, and an economical process. Within the construction management literature there seems to be a growing interest in the social factors of the construction processes. Recent accounts of such a growing interest are, e.g. need for effective leadership in cultural change (Keiser, 2012), and the use of incentive systems to support collaboration (Schöttle and Gehbauer, 2012). As pointed out by Slivon et al. (2010) there is a need to pay attention to what takes place when people work together. The increased use of subcontractors necessitates an emphasis on human and relational aspects (Kerzner, 2009, Meredith and Mantel, 2009, Jones and Lichtenstein, 2008), and not on technology alone (Shelbourn et al., 2006). The 'soft' and 'hard' concepts suggested by Shelbourn and colleagues (2006) is in line with the two dimensions suggested in current research, which also touches upon the content of Jones and Lichtenstein (2008) accounts of temporal and social embeddedness on page 20 of this thesis. As sug-

gested by data in the current research, tools and techniques adopted may support and reinforce cultural cohesion (Cameron and Quinn, 2006).

Researchers within the relational view (page 4) suggest that behaviour legitimacy, sense of time urgency, interaction frequency and enjoyed power constitute categories of relational factors that impact on relationships (Dyer et al., 2010) and thus touches upon themes and concepts discussed in current research. Meng (2010) identified key relationship indicators, some of which support findings in this research, such as sharing or withholding of information and learning, problem solving and conflict resolution, open and effective or ineffective communication, teamwork or fragmentation, common/self-objectives and mutual trust/suspicion/mistrust.

With reference to Howell (2004) there is still a lack of a comprehensive theoretical foundation that explains how project management can fully involve and engage people. Current research has contributed towards such a theoretical foundation. The case stories contributed to accounts of established rules for coordination (Dyer and Nobeoka, 2000) to enable knowledge creation and recombining. Arenas and space for involvement (Auch and Smyth, 2010) were established, e.g. in kick-off seminars, progression planning meetings and shared office facilities.

In line with Huemer (1994), communication, motivation and trust building were found to be crucial elements for developing collaboration. The case stories evidenced trust building in the form of 'small wins' (Vrijhoef et al. (2001) by articulating and keeping promises, creating a network of commitments (Slivon et al., 2010). In line with Coffey (2000), involvement, in current research, was an active manifestation of commitment.

Already from the outset of the construction projects, information sharing was facilitated, and personal relationships developed, which Eccles (1981) found to be crucial for trust building. Informant statements suggested that familiarity was important to develop trust and understanding, which supports previous research (Gulati, 1995, Bee and Bee, 1997, Brown et al., 2010). Familiarity was developed by information sharing and discussions, which Hult et al. (2004) suggested could help developing a common mind-set about issues.

Dainty et al. (2001b) found a reluctance to utilise subcontractor expertise in problem solving, which to a large extent was not found to be a barrier for collaboration in current research. This is supportive of Sacks and Harel (2006) who suggested that the Last Planner System encourages more collaboration, and may dampen a possible negative act-react interaction loop. Indeed, by inviting the opposition (Falkum, 2007) into prob-

lem solving in daily operations, commitment, initiative and enthusiasm among project participants may be supported. Such interaction may stimulate participants to adopt a perspective of different 'others' (Rommetveit, 1980). By emphasising discussion of dependencies, data suggested that a perspective of 'others' was adopted. This is also in line with network thinking (Gadde and Håkansson, 2001), and may contribute to a lesser extent of managing relationships in isolation (Ritter, 2000). Gray and Larson (2000) also stress the role of the project manager in shaping a collaborative culture.

Quantitative results were weaker (significance) than qualitative findings in this research, and although care must be taken in terms of generalisability based on case studies, Yin (1984) suggests that case studies may generalise theoretical propositions based on analytical rather than statistical approaches. Based on findings in this research, it may be argued, that some 'collective programming of participants minds' (see Hofstede, on page 12) had taken place in the case study construction projects by the use of progression planning tools. The main programming, it may be asserted, involved dependencies and relationships.

Causes and effects

A neighbouring issue to discuss in light of the above reported theorisation of the findings is the structural and relational dimensions in a 'chicken and egg' perspective. What comes first in a construction project in which collaborative planning methodologies are used? What affects what? Is it the structures, procedures and tools that enable better collaboration? Or can it be argued that certain relational elements must be in place prior to establishing collaborative structures? Is, e.g. enhanced project commitment a result of collaboration being made possible through new collaborative structures, or a result of collaboration being made possible by the ability and willingness to talk to each other in a new way, to listen to and respect other trades' needs, and to show interest in an overall approach to carry out a project?

What are causes and what are effects? Based on findings in this research it may be argued that all of the six collaborative dimensions may cause collaborative relationships to develop. At the same time this research argues that degrees of each collaborative dimension are signs of collaborative activity taking place.

6.6 Summary

In this chapter, results have been presented and discussed. First, each of the three separate research parts was accounted for on page 162 onwards, followed by a discussion of implications for practice and theory. In the implications for practice section, the six collaborative dimensions used in this research were discussed in terms of structural and relational aspects of the use of progression planning tools. Reported barriers to collaboration were also noted and discussed.

Then implications of findings for theory were discussed. In this section findings were presented using an ethnographic approach of first order themes, second order concepts and third order dimensions. An argument was built that the two overarching structural and relation dimensions need to be attended to in interplay in the use of progression planning tools, in order to affect main contractor subcontractor relationships.

Chapter 7 Conclusions and suggestions for further research

7.1 Introduction

The DBA project accounted for in this thesis consisted of three separate research projects referred to as part I, II and III research. The three parts had different perspectives in studying the relationship between the use of progression planning tools and the development of main contractor subcontractor collaborative relationships in Norway. Data analysis was performed for the three parts, both separately and combined. Results of these analyses were presented in chapter 6. This chapter concludes based on the results, and state contributions to practice and theory. Finally, in section 7.3 on page 189, based on this DBA project, suggestions for further research are offered.

7.2 Conclusions

The main research question to be answered in this study was

Can collaborative progression planning tools be used to increase the degree of collaboration in construction projects in Norway?

Based on the combined findings in this study, the use of progression planning tools *can* be used to increase the degree of collaboration in construction projects in Norway. However, as demonstrated in the quantitative study, the effect of such use on the main contractor subcontractor collaborative relationship, only partially, is significant within the 95 percent level of significance. The qualitative research into the use of progression planning tools concludes that there were variations in the approach to progression planning, although initially based on the same collaborative planning methodology. Thus, it may be concluded that *how* progression planning tools or methodologies are used may be more important than the actual methodology in itself.

Variations to the use of progression planning tools, or methodology, were both structural and relational. Based on the results of the combined research results, it may be concluded that several decisions need to be made concerning methodology structures and systematics. Firstly, there is a need to establish meeting preparation and behaviour guidelines. Project management may provide clear and unambiguous expectations already in the contractual process, or later in the start-up phase. Secondly, a systematic approach to meeting structures and meeting implementation needs to be established. Decisions need to be made concerning e.g. meeting regularity, organisation of planning levels, participation, and purposes of each meeting to ensure an effective meeting. Thirdly, communicative tools, such as electronically developed plans, need to be developed to ensure that all participants understand plans and interdependencies, and are able to provide relevant information input into the joint progression planning. Fourthly, decisions need to be made concerning involvement in progression planning. The involvement aspect applies to whether or not to involve own main contractor employees and subcontractors, and substantial decisions about the scope of involvement. It may be concluded that all above issues are important to improve collaborative relationships.

Likewise, several aspects need to be attended to concerning social and relational issues of implementing the collaborative progression planning approach. Firstly, communicative behaviour patterns, such as engagement in discussions and information sharing, promise making and demonstrating willingness to make commitments, need to be initiated, stimulated, and motivated, not only from the outset of the construction project, but throughout the lifespan of the project collaboration. By nurturing such communicative behaviour, the participants may develop a project culture based on trust and openness. Secondly, and related to communicative behaviour, is the interactive behaviour within the group of participants. Interactive behaviour in this research refers to the various ways in which the participants can demonstrate interest and understanding of each other, by conducting an attentive and respectful behaviour. Thirdly, based on this research, it may be concluded that management has a crucial role in initiating, motivating and encouraging communication in progression planning activities and meetings. Fourthly, a purposeful focused communication is important to improve collaborative relationships. This can be ensured by a strict attention to production dependencies, to finding mutual solutions, by a systematic approach to removing obstacles for future production activities, and to collaboratively discussing and finding the right order of activities.

A conclusion offered is thus that a holistic approach needs to be taken in the use of progression planning tools, to have a potential effect on collaborative relationships. That means that an equal attention is given to the structures and systematics of the collaboration, as to the interpersonal and social aspects of collaboration.

7.2.1 My contribution to practice

An ambition with a thesis submitted for the degree of Doctor of Business Administration is that knowledge obtained from research should provide explicit advice of value to practitioners in the field of study. This ambition has been kept in mind throughout the research process. Case descriptions and findings illustrate and exemplify an ongoing process of implementing a collaborative planning tool. To many project managers, implementing a collaborative planning methodology, either based on The Last Planner System of control, or adaptations of the methodology, constitute a change process from a traditional approach to planning, to a planning process conducted jointly with subcontractors. Given the nature of a transition to a collaborative approach to planning, contractor relationships implicitly will be affected. This study demonstrates the importance of an awareness of taking into account both a structural and a relational dimension of collaborative use of progression planning tools.

In other words, it is not just a matter of applying tools and techniques in a construction project to gain production control. It is ultimately about people working together, to pull in the same direction towards a known goal. The humans who make up the project team are the ones who carry out the planned activities. Therefore it is necessary to adopt a holistic approach to the use of progression planning tools. This involves an attention to decisions about tools, procedures, frameworks, interactive arenas, etc., together with an awareness of how to stimulate social processes that will unfold in the project. It is hoped, that the method of presenting the cases can act as exemplifying descriptions capturing both structural and relational dimensions, from which managers may extract knowledge of importance to their own collaborative progression planning endeavours.

7.2.2 My contribution to theory

This was an empirical study of collaboration in a project based form of production setting. The study simultaneously addressed the use of tools and techniques (structure and methodology), and social relations (interaction and communication) at once, and concluded that the two dimensions may have supportive and developing effects on each other. The Lean Construction literature provides research accounts of previous imple-

mentation processes based on LPS. Often the focus has been on opportunities for improvements in terms of, e.g. increased control of planning, or increased production efficiency. On occasions, the implicit effects of the use of LPS on working relationships have been described.

My contribution to theory is an empirical basis for studying both structural (tools and methodology) and relational (collaborative culture) aspects while using collaborative progression planning in project based production, such as construction. Based on the results of this study it may be asserted that validity of the findings may exceed that of a construction project environment. As project based production is increasing globally, it may be assumed that innovative actions (tools, techniques, methodologies) will emerge which aim to produce some measure of improved performance. Findings in current research suggest that the claim that use of progression planning tools must focus on both the human and structural aspects simultaneously to develop collaboration, may also apply to similar settings where several companies together, in either an equal or hierarchical association, produce goods or services.

Thus, this research contributes to the construction management knowledge base by addressing *how* the use of progression planning methodologies may be approached as a process including a combined attention to structural and relational dimensions of such use.

7.3 Further research

This research has studied whether collaborative progression planning tools may be used to increase the degree of collaboration in construction projects in Norway. Research scope and other limitations made it impossible to pursue all the interesting and important research questions which emerged in the process. Some research questions emerged from being closely related to the researched issues, although still not appropriate to pursue within the scope and context of the project. Some research findings emerged that would be interesting to follow up in terms of verification, e.g. similar research approaches in other contexts (geographical, market, collaborative cultures). Lastly, some research questions emerged from findings and results, which would constitute natural next steps in developing a comprehensive theory in a project based production setting.

7.3.1 Relationship X - Y Part I

Further research is suggested into the relationship between X and Y, based on part I of current research:

1. How may increases in productivity performance or other performance measures be measured within project based production settings?

    a. Are productivity gains equally distributed?
    b. How may the use of collaborative contracts, such as a partnering contract, affect project outcomes and effects?

The literature review suggested that productivity and other performance measures had been obtained from implementing collaborative planning methodologies. However, as variability in construction projects affects how performance can be measured, and that multitude of goals exists, a study may be feasible that established valid productivity measures. Also, provided that a large degree of construction projects are carried out as subcontracts, a timely research questions is whether eventual productivity gains are equally distributed between contractors, and whether or not partnering contracts may prevent potential inequalities.

2. How may inequalities between project partners in the use of pay schemes affect the development of collaborative relationships?

    a. Can project level financial incentives remedy such inequalities?

A related issue to developing collaborative relationships in this research was the impact of diverse practices of pay schemes among the collaborating contractors on the development of collaborative relationships. The literature review suggested some barriers to collaborative relationships of uses of pay schemes, and it may be argued that more in-depth knowledge of these practices may be a valid approach to influence change processes towards project level incentive systems to ensure a win-win situation.

3. What is the reasoning behind the diversity of adapted versions of the use of progression planning tools, which effects does such diversity have on organisational development processes?

As concluded in current research, variations exist to a large extent in terms of practises of collaborative planning. An industry-wide improvement in collaborative relationships is called for, both by academics and professionals. More knowledge of the impact of project level diversity in collaborative planning approaches on organisational development processes may shed light upon requirements for extending project levels attempts, to company and industry collaborative development.

7.3.2 Relationship Y - Z Part II

Further research is suggested into the relationship between Y and Z, based on part II of current research.

1. How may barriers to developing collaborative relationships be overcome, reduced or managed in project based production settings?

Findings in this research included barriers to developing collaborative relationships, and although the research scope prevented a thorough study of these barriers in current research, it may be suggested that additional empirical studies could result in in-depth knowledge of practices to overcome the barriers and how practices could be managed. Such empirically based studies may potentially be of direct value to practitioners.

2. Do project managers possess the skills and competences necessary to develop relational aspects of conducting projects within a technological and logistical project based production setting?

    a. To which extent is psychological, sociological and organisational issues part of the formal education towards project management?
    b. How may an increased use of collaborative progression planning tools cause increased project manager awareness of relational aspects of conducting construction projects?

Project managers, it has been concluded, have a crucial role in developing collaborative relationships within construction projects. Expanding on current research, it may be relevant to study whether the formal education provided for potential project managers is sufficient to cover all aspects of conducting projects, i.e. the interface between technology/logistics and social/relational dimensions.

3. How may contextual (e.g. geographical) differences in labour tradition and culture affect implementation of collaborative planning and hence development of collaborative relationships?

The literature on Lean Construction is based on studies of implementing lean thinking and the Last Planner System in many parts of the world. To what extent are practices dependent upon local labour traditions and culture? Exploring such questions may provide valuable insight into opportunities as well as barriers for improved collaborative relationships.

7.3.3 Relationship X - Z Part III

Further research is suggested into the relationship between X and Z, based on part III of current research.

1. Study of differences between use of progression planning tools and traditional approaches to planning (see page 3) and effects on collaborative relationships.

    a. More survey data on similar approaches to conducting construction projects to verify (or not) conclusions from current research.

For comparative reasons, it would be interesting to explore the collaborative approach to planning vs. the traditional approach. Insights into differences and similarities may shed light on the importance of the structures and systematics offered by the LPS on the one hand, and people skills on the other hand.

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Appendices

Appendix A: Participating companies in this research

Participating company Part I (Case study company B)

The Norwegian construction company is based in the South-west part of Norway and is organised in two regions and several districts. The company undertake new constructions and rehabilitation projects. In 2008, LPS was first implemented in two pilot projects (Skinnarland and Moen, 2010, Skinnarland, 2011). Since then, top management has decided that LPS is a collaborative methodology to be used in all projects within the company.

Participating companies Part II

Case study company A is a Norwegian based construction company with more than 6000 employees. The company is the largest in Norway, and fourth largest in Scandinavia. A core activity is building and construction operations, taking place in Scandinavia. Their Norwegian operations are organised in regional, district and section offices, and subsidiaries. The local units have a great degree of independence in terms of exploiting markets, customers and opportunities. A high percentage (approximately 85 percent in 2011) is turnkey contracts, where contractors are responsible for both design and execution.

Case company A's stated ambition is to *"develop the business further, with the most satisfied customers, the most competent and motivated employees and the best profitability.* This ambition is founded on the values of continuous improvement. Case company A is actively engaged in improvement initiatives in terms of improved planning and implementation of individual construction projects. A self-developed planning methodology was inspired by the International Lean Construction community, and is central to the improvements efforts. The planning methodology main ambition is to provide the best possible production flow, which includes planning across different time horizons, systematic removal of production obstacles, and stakeholder joint participa-

tion in planning their own daily activities. The improvement initiatives target improving the overall process in which clients, suppliers (consultants, subcontractors and material suppliers) as well as the company's own contributions are crucial to succeed in the best possible way. (From company official annual report 2011).

Case study company B is a family owned construction company and one of the largest building contractors in Norway. Their vision is '*From idea to reality*. Their operations are organised within regional offices, and the core activities comprise building, construction, housing and property development. The company have 960 employees.

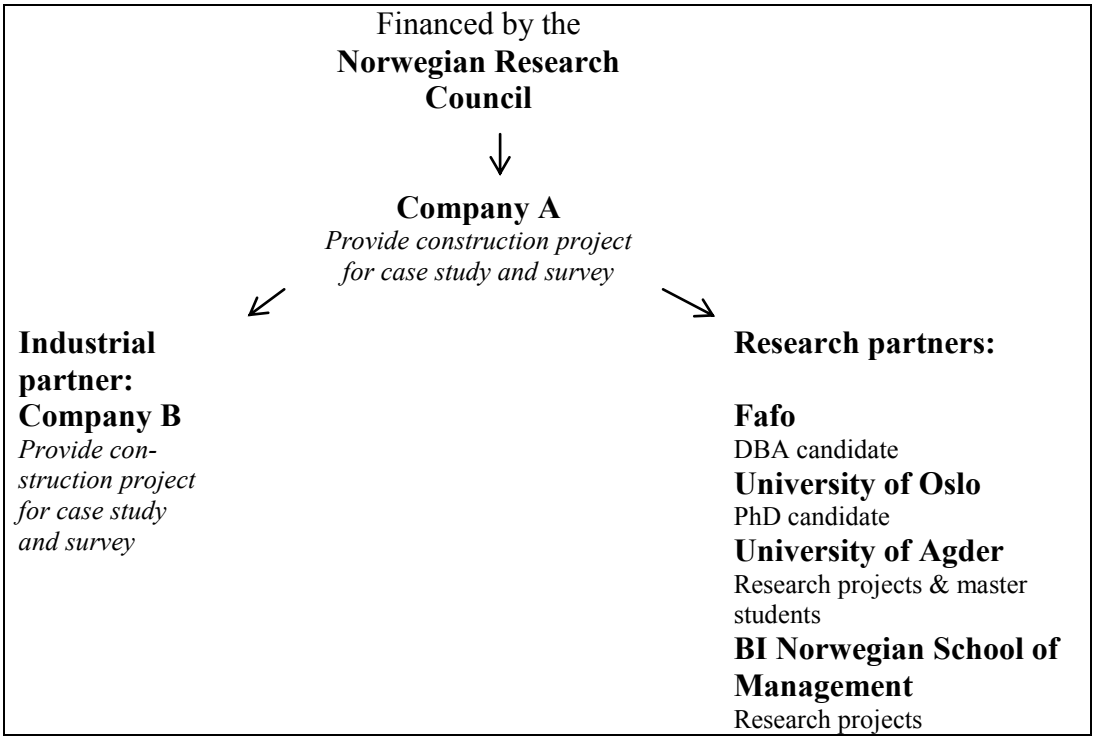
Case study company B has a continuous focus on R&D activities, with a main mandate to keep up-to-date with new methods, processes and materials that can be used to make building projects more efficient. R&D devoted a large proportion of its resources in 2011 to implementing "Lean" in the organisation. Since the implementation of two pilot projects in 2008, top management has decided that all construction projects follow suggested guidelines for lean implementation (collaborative planning). (From company main web page).

A.1 Criteria for selection of case studies

The two construction projects that this research was empirically founded on were selected on the basis of ongoing development programs in the two companies. The development programs include implementation of collaborative progression planning processes in their building projects. A second criterion for selection was project managers' consent to cooperate and to offer full access to data collection. For the pilot stage and main study combined the two companies combined offered access to a total of four projects for longitudinal case studies (Part II), and 16 projects in the quantitative survey (Part III). Additionally, construction company B provided access to project managers and foremen to the Part I study.

DBA project organisation

Company A is the main project partner in a large research program financed by The Norwegian Research Council. The second industrial partner is Company B. In addition, there are four academic partners, see figure 1 below.



Appendix figure 1. Organisational structure of research programme.

Source: author.

A.2 Collaborative planning in the case study companies

Company A has adapted, refined and tested new planning methodologies (collaborative planning) based on a bottom–up approach to planning for on-site project based production. Collaborative planning in Company A was formally initiated in 2006 as six pilot projects (first phase of Company A's development program) implemented the new planning methodologies. From 2009 and onwards more projects (second phase) implemented the planning methodologies and the empirical basis for this DBA project was drawn from these.

Company B did also initiate similar attempts to increase the involvement of own employees and subcontractors in the progression planning of their projects. First initiatives were taken in 2008. A number of projects have received support from internal resources.

Collaborative planning in these companies entails that people closest to production, supervisors or even trade workers, are given responsibility to plan in detail for the up-

coming week. The middle (foreman) and upper management (project management) is in charge of planning for the next five – nine weeks, making ready and removing obstacles to tasks to be carried out when maturing into the (rolling) weekly work plan.

The main contractor project management team bring in subcontractor project managers and foremen/team supervisors as well as their own foremen/team supervisors to plan jointly. This differs from traditional planning in the sense that the various trades would, to a larger extent, plan their own work which would not be coordinated with other trades' plans.

Meeting structure and planning levels

Meeting structures were established to accommodate planning for different time horizons. Progression planning meetings were largely structured as follows:

Meetings and associated planning levels	
Team meeting (Team plan)	A meeting (usually weekly or every two or three weeks) for tasks to be planned at the individual level, about a week ahead
Supervisor meeting (Weekly plan)	A weekly meeting where team supervisors and subcontractors together review and update the weekly schedule, about two to five weeks ahead
Lookahead planning meeting (Lookahead plan)	A meeting (usually weekly or every two weeks) where management and subcontractors review and update the lookahead plan, about five to nine weeks ahead
Start-up meeting	A kick-off meeting where information about the project is provided, where both own employees and subcontractors may be present

Appendix table 1. Meeting structure and planning levels.

Source: author.

A.3 Informants roles in the building projects

Workers in this research may be apprentices, skilled or unskilled trade workers. Team supervisors were directly in charge of workers on the building site and responsible for daily operations within their teams. Foremen's role varied to some extent, from being present on the site following up production, to mainly carry out their functions from the building site office, or a combination depending on project specifics, such as size and complexity, and on personal preferences.

Apprentice	Worker
Unskilled worker	
Skilled worker	
Team supervisor	Team supervisor
Foreman	Management
Progression Planner	
Operations manager	
Site manager	
Project manager	
Officer	

Appendix table 2. Grouping of positions.

Source: author.

A.4 Informants part II

Interview No	Role	Main contra-cor (MC) Subcontractor (SC)
1	Site Manager	MC
2	Operations Man-ager	MC
3	Project Manager	MC
4	Project Manager	SC
5	Project Manager	SC
6	Project Manager	SC
7	Foreman	MC
8	Foreman	MC
9	Foreman	SC
10	Team Supervisor	MC
11	Team Supervisor	MC
12	Team Supervisor	MC
13	Team Supervisor	SC
14	Team Supervisor	SC
15	Worker Group	MC x 4
16	Worker Group	MC x 3
17	Worker Group	SC x 3
18	Worker Group	SC x 2

Appendix table 3. Informants Case A, Part II

Source: author.

Interview no.	Role	Main contractor (MC) /subcontractor (SC)
1	Project Manager	MC
2	Operations Manager	MC
3	Trainee	MC
4	Project Manager	SC
5	Project Manager	SC
6	Project Manager	SC
7	Foreman	MC
8	Foreman	SC
9	Foreman	SC
10	Team Supervisor	MC
11	Team Supervisor	MC
12	Team Supervisor	SC x 2
13	Team Supervisor	SC
14	Worker Group	MC x 2
15	Worker Group	MC x 2
16	Worker Group	SC x 3
17	Worker Group	SC x 4

Appendix table 4. Informants Case B. Part II.

Source: author.

Appendix B: Pilot study report

Introduction

Limited research existed on the use of collaborative progression planning tools, in developing main contractor subcontractor relationships. A pilot study was therefore conducted to test the feasibility of the research methodology proposed in the research programme.

The objectives of the pilot study

The research programme was designed to address the research question from different perspectives

- Functional relationships between the use of collaborative progression planning tools and improved collaborative relationships
- How progression planning tools may be employed to positively influence this relationship

The pilot study tested the following objectives:

Quantitative element:

- Do respondents respond to the survey questionnaire as intended?
- Is the data collection method appropriate?
- Can appropriate indicators of collaboration be established?
- Is any refinement necessary?

Qualitative element:

- Do respondents respond to the semi-structured interview guide as intended?
- Is any refinement necessary?
- Is the triangulation of methods optimal to answer the various perspectives of the research question?

Methodology

The proposed research design suggested a pilot study use of a quantitative and a qualitative approach to data collection. In the qualitative element of the study, a case study (Yin, 1984) approach with interviews and observation in progression planning meetings

were conducted. For the quantitative element a survey questionnaire was developed to establish variables, or *indicators* of collaboration, to be used in the main study.

Selection of pilot study sample and data collection process

Two construction projects, (Company A and B), were selected for the pilot study. They were both selected qualitatively using a non-probability, purposeful sampling method to ensure information rich cases (Patton, 1994). Both projects implemented collaborative planning methodologies based on the Last Planner System (see chapter 2.4). Interviews with 32 people, from main contractors and subcontractors, were conducted. Transcripts were made and later analysed.

For the quantitative study, four construction projects where selected which were implementing collaborative planning methodologies (Company A and B). Based on the research design proposed, the sample was again specifically and qualitatively selected (Patton, 1994), rather than randomly drawn from a large population, on the same basis as noted above.

Interviews and observations in meetings were conducted during several visits to the construction sites over a period of a few months. Three projects in the quantitative survey were visited by the researcher and printed questionnaires were handed out during lunch breaks. Prior to the visits, the project managers had agreed to facilitate the data collection process. Some project managers had informed subcontractor project managers that a survey was to be conducted and asked them to motivate their employees to participate. The fourth project had already finished, but the project manager felt he had good contact with the subcontractor project managers. An e-mail with enclosed questionnaires was sent to the project manager, who then forwarded the e-mail to subcontractor project managers, with an invitation to participate, together with a note of support of the survey. Participants were asked to scan and return the questionnaires directly to the researcher by e-mail.

Response rate

The population was considered to consist of all workers and managers present on the building site, on a specific day, and in a specific time period. A total of 120 people were approached with an invitation to fill out the questionnaire. 10 declined, and 110 respondents returned the questionnaire. This gives a response rate of 91,7 percent. The 10 people that declined based their decision either on language barriers, or recent entry into the project (less than a week prior to the survey). As a sign of appreciation for participation, a lottery ticket was issued to each of the respondents, motivated by a desire to

boost the response rate. None of the respondents were observed to participate in the survey based on receiving the lottery ticket alone, however, the lottery element created a positive and cheerful tone, which may have inspired respondents' endurance. Lottery tickets were not issued in the main study. The rationale behind the attempt to boost response rate in the pilot study was to ascertain that the response rate was high enough for statistical analysis to be conducted.

Enquiry about the questionnaire

In the process of collecting responses to the survey questionnaires, a randomly selected sample of approximately 20 percent of the respondents were approached and invited to comment on different aspects of the questionnaire in terms of length of time needed to answer, use of language and concepts, etc. Comments were made concerning relevance, foreign workers and language barriers, language simplicity and similarity, and a mix of concepts. One questionnaire was developed for all respondents, and thus not all felt that each question was relevant to them. This was corrected in the main study such that headings indicated who should answer each question. The questionnaire was presented in Norwegian only in the first project visited. In the consecutive visits, also an English version was presented. In the main study both languages was available. Comments on simplicity was attended to by reducing number of indicators used and slightly adjusting order of questions and suggested omissions. The similarity comments were made regarding indicators. This was expected, as nuances of indicators were presented to include all variants found in the literature and previous research by the author. Comments about use of concepts indicated that two sets of questionnaires should be developed for the main study. However, the majority of the people approached and asked to comment upon the questionnaire, expressed that they did not encounter any problems in filling out the form.

In terms of time spent answering the questionnaire the approximate range was 12 – 30 minutes, with the most frequent time spent being between 18 and 23 minutes. These estimations were based on approximate assessment rather than accurate time recording, as respondents entered and left the lunch facilities in groups of three to seven people.

Data analysis

The qualitative data gathered was analysed using thematic analysis (Fereday and Muir-Cochrane, 2008). In establishing themes when analysing the transcribed data, comparison was a dominant principle. Comparison is a purposeful approach to systematise data from interviews (Boeije, 2002), which enables theory development inductively by de-

lineating and connecting categories of data. Boeije (2002) and her colleagues developed a procedure for this technique starting with internal comparison within a single interview, and later comparisons between interviews in one group and comparisons within groups of interviews. No software program was applied in this process.

The main objective of the data analysis was to test whether the semi-structured questions were understood in terms of language and concepts used. In general, the interview guide proved to meet both objectives; however, the analysis revealed useful probing questions that were later included in the main study. In terms of observations made, the objective was to investigate whether information given in interviews were manifested into alleged behaviour in progression planning meetings. The observation protocol captured expected behaviour, and was regarded a useful tool for the main study.

The quantitative data was analysed using SPSS 15.0 (Statistical Package for the Social Sciences). The analysis had two objectives; to analyse variables to reduce the number of indicators of collaboration to be used in the main study, and to test whether the survey construct would give information concerning the functional relationship between collaborative activities performed and any effects on the relationship between the stakeholders.

Reducing the number of variables

Cronbach's Alpha (CA) was used to test the internal consistency (reliability) within the set of variables. CA tests whether a set of items are consistent with one another, to such a degree that they can be combined in a single scale reference (Berglund, 2004). Following a qualitative grouping of thematic indicators, the purpose was to create a new index which provide a summary and reflect a large number of variables. This approach (CA) to testing variable consistency and to produce a final set of indicators has been performed in previous research, both in international business studies, e.g. on testing variables which influence multinationals' foreign entry mode choices (Kim and Hwang, 1992), and more frequent, in health care research, e.g. (Engels et al., 2006).

Findings/results

In the following sections, each of the pilot study objectives outlined on page 217, is discussed in relation to analysis of the quantitative and qualitative data.

Quantitative element:

In this section, the results of the quantitative element in the pilot study are outlined according to whether respondents responded to the survey questionnaire as intended;

whether the data collection method was appropriate; and whether appropriate indicators of collaboration could be established.

– *Do respondents respond to the survey questionnaire as intended?*

This objective can be subdivided into several objectives:

– *Do respondents respond to all parts of the survey questionnaire?*

The survey questionnaire consisted of a number of close-end questions and a set of variables to be scored. The number of respondents tended to drop slightly towards the end, suggesting the questionnaire was too long. Also, the number of respondents that chose 'Not sure' increased slightly towards the end, suggesting that the questionnaire was too long and respondents made it easier for themselves by answering 'Not sure' towards the end. However, this finding was expected. The number of statements concerning collaboration based on previous research by the researcher (Skinnarland and Yndesdal, 2010, Skinnarland and Moen, 2010, Skinnarland, 2011) and the literature review, (Gottlieb et al., 2005, Browning et al., 1995, Baiden et al., 2006), was high. The decision to still include all in the pilot survey was based on the need to statistically arrive at a lower number of statements to be tested in the main study.

Some questions with lower *n* indicated that the sequence, in which questions were asked, influenced the level of *n*. The sequences were adjusted for the main study, and unnecessary questions omitted.

– *If not, what is left out?*

A pattern was found of specifically omitted questions. The omitted questions were included in the following example format:

☐ Exist in the project
Have you participated in the preparation of such a plan?
☐ Yes ☐ No ☐ Not sure ☐ Not applicable
☐ Does not exist in the project
☐ Not sure } proceed to question 4

Questions of this format were later dealt with by reducing complexity and omitting unnecessary questions to improve clarity.

– *Do respondents understand the words and concepts used?*

A slight divergence of understanding of the concepts by the two main constructions companies was detected. This did not cause any problems, as the researcher was present and could provide clarifications. As this was company specific rather than individual, an adaptation to the companies was suggested.

– *Do respondents understand how to fill in their answers?*

A few closed-end questions were ticked twice, as they presented a hierarchical order, such as education. This may be attributed to unclear explanations and was corrected before the main study.

– *Is the data collection method appropriate?*

The decision to visit the construction sites and be present while respondents were filling out the questionnaires was correct. Although many respondents answered the questionnaires simultaneously, the researcher was available to address any concerns regarding the survey questionnaire. Further, the very presence may even have positively influenced the response rate. In the main study this procedure was repeated by the researcher.

– *Can appropriate indicators of collaboration be established?*

An internal reliability analysis was used to analyse a total of 54 variables used in the pilot study, which represented statements of project participants' own experiences in terms of collaboration in the current project. The overall objective of the reliability test was to reduce the number of variables to be tested in the main study.

A qualitative assessment was initially conducted of the 54 variables and grouped into 14 dimensions, to be tested using reliability analysis. The following section summarises the quantitative testing process and the output analysis. A description is given for the first scale.

1 Scale: Collaboration indicated by a sense of group cohesion

Reliability Statistics:

Cronbach's Alpha	Cronbach's Alpha Based on Standard-ised Items	N of Items
,899	,900	8

Appendix table 5. Reliability statistics for scale 1. Collaboration indicated by a sense of group cohesion.

Source: author.

Reliability statistics for scale 1

Item-Total Statistics

	Cronbach's Alpha if Item Deleted
s2_cNEW	,892
s2_fNEW	,889
s6_aNEW	,881
s6_cNEW	,878
s6_eNEW	,890
s11_bNEW	,886
s11_jNEW	,892
s11_oNEW	,879

Appendix table 6. Item-total statistics for scale 1: Collaboration indicated by a sense of group cohesion.

Source: author.

The Cronbach's Alpha (Cronbach, 1951) tested whether the variables represented a variable labelled "collaboration as indicated by a sense of group cohesion". The overall Cronbach's Alpha value was .899, which indicated high internal consistency between the variables. A Cronbach's Alpha of less than .70 would suggest less than adequate reliability, (or consistency of measurement).

The item-total statistics showed how CA would develop if any items were deleted from the scale. As deleting any of the items still provided a CA well above the .70 commonly accepted reliability limit, the test showed high scale reliability, or internal reliability (Hair et al., 1998).

Appendix table 7 show a summary of the analysis of the internal reliability showing the 14 scales in column 1. The second column shows the Cronbach's Alpha value, and in the third column the results of the analysis appear. If analysis shows no internal reliability, any actions required are stated in column 5. In the last column, the end results after any action appear.

	Cronbach's Alpha	Analysis	Action and Result from any actions
1 Scale: Collaboration indicated by a sense of group cohesion	.899	Internal reliability	No further action required
2 Scale: Collaboration indicated by a sense of working towards common goals	.751	Internal reliability	The output suggested an improvement if one item is deleted.
3 Scale: Collaboration indicated by communicative interaction	.831	Internal reliability	No further action required
4 Scale: Collaboration indicated by a sense of involvement	.878	Internal reliability	No further action required
5 Scale: Collaboration indicated by a sense of joint problem solving	.705	Internal reliability	No further action required
6 Scale: Collaboration indicated by a sense of less blaming	.745	Internal reliability	No further action required
7 Scale: Collaboration indicated by a sense of satisfaction	.368	No internal reliability	Output suggested improvement if one item deleted. New CA improved to .821.
8 Scale: Collaboration indicated by a sense of commitment and responsibility	.597	No internal reliability	Output suggested improvement if one item deleted. New CA improved to .719. However, the new output showed negative values, and thus no internal reliability.
9 Scale: Collaboration indicated by a sense of an interest in other's work	.878	Internal reliability	No further action required
10 Scale: Collaboration indicated by a sense of sharing and helping	.764	Internal reliability	No further action required
11 Scale: Collaboration indicated by a sense of equality	.777	Internal reliability	No further action required
12 Scale: Collaboration indicated by a sense of predictability	.821	Internal reliability	No further action required
13 Scale: Collaboration indicated by a sense of structure	.477	No internal reliability	No further action can improve CA above the adequate level
14 Scale: Collaboration indicated by a sense of learning	.772	Internal reliability	No further action required

Appendix table 7. Analysis of internal reliability.

Source: author.

Analysis of internal reliability using Cronbach's Alpha

The fourteen scales were tested for internal reliability using Cronbach's Alpha (Cronbach, 1951). Out of the fourteen scales, eleven scales showed internal reliability, or, scale consistency. Three scales showed Cronbach's Alpha below the .70 commonly accepted reliability limit, and even below the accepted .60 limit in exploratory research (Hair et al., 1998).

One of the scales (7) improved its Cronbach's Alpha above the adequate limit by deleting one of the items. For scale 8 the resultant CA improved to .719. However, the new output showed negative values, which may be interpreted as providing no information about the reliability (Lord et al., 1968). This means the items in scale 8 had to be included in the survey separately. For scale 13, no deleted items could improve the

Cronbach's Alpha above the acceptable limit and thus these variables also had to be dealt with separately.

The reliability analysis created a basis, upon which a substantial qualitative assessment of the selection of statements to be included in the main study, were carried out. This is in line with Berglund (2004) who proposes that use of indexes to reduce the number of variables, should not be a matter of mere technique, but rather, an emphasis must be placed on the qualitative assessment, thus both techniques are needed. The following criteria were used to qualitatively assess the selection process: a) the basis of similarity and overlap in questioning; b) the size of *n*, although the week tendency for *n* to drop towards the end of the questionnaire was considered; c) possibility of merging variables; d) an analytic approach to cause and effect; e) scope of statements, in terms of whether the statement contributed to answering the research question.

Below is a summary of the suggested statements later to be included in the main survey.

Collaborative planning...

contributes to contractors working as one team
influences contractors to increasingly work towards a common goal
contributes to closer dialogue between contractors
enables me to be more involved in the construction process
helps us to jointly solve problems at an early stage
contributes to fewer conflicts and blaming/criticism among contractors
contributes to increased job satisfaction
makes me commit to take more responsibility in the project
makes me more interested in other trades' work processes
positively affects contractors to offer a helping hand and to share resources
positively affects the perceived equality among contractors
gives me greater confidence that promises made by other trades are kept
contributes to more structured meetings
contributes to a tidier and more organised site
makes me focus more on improvement and learning

The survey questionnaire for the main study was updated according to the reduced number of variables resulting from the pilot study.

– *Is any refinement necessary?*

Some refinements to the quantitative survey questionnaire were deemed necessary and were corrected prior to the main study.

Qualitative element, interviews:

In this section the results of the qualitative element of the pilot study is outlined. The section addresses the issues of information extraction concerning the suggested relationships, response to the semi-structured interview guide and triangulation.

– *Is information concerning how progression planning tools may be employed to positively influence such relationships extracted as intended?*

The semi-structured interview guide proved to provide both the sufficient number and scope of questions required to address how progression planning tools may be employed to positively influence such relationships. Probing questions were detected that enriched the interview guide and was added in the main study.

– *Do respondents respond to the semi-structured interview-guide as intended?*

This objective was subdivided into several objectives:

– *Do respondents answer all questions in the interview guide?*

None of the respondents declined to answer any of the questions. Each of the interviews started with a clear statement of confidentiality and interviewees seemed relaxed and outspoken in the interviews.

– *Do respondents understand the words and concepts used?*

The slight problem with a difference in use of certain concepts and terms, as referred to above, was not experienced in the interviews. The wordings were adjusted to company specific terms.

– *Do respondents understand how to answer the questions?*

No misunderstandings were noted by the researcher, indicating that questions asked were unambiguous and clear.

- *Is any refinement necessary?*

Based on the above findings, no refinement of the interview guide was deemed necessary for the main study. However, some probing questions were later included.

Qualitative element, observation:

In addition to interviews, observations in progression planning meetings were conducted. This section outlines the results of the observations in terms of the objectives related to the use of this research method, and in terms of the triangular effects of the chosen methods.

- *Do the observation method illustrate whether information given in interviews were manifested in alleged behaviour in the progression planning meetings?*

Observing in progression planning meetings added useful information concerning collaborative interaction addressed in interviews. As such, this method was also adopted in the main study.

- *Is the triangulation of methods optimal to answer the various perspectives of the research question?*

Based on findings referred to above, it seemed that a triangulation between methods would enrich the data, and therefore was later employed in the main study.

Changes to guide/survey questionnaire

Based on the findings reported above, some changes were made to the questionnaires used.

Survey questionnaire:

- *Less ambiguity in terms of who should answer a specific question.*

Example:

Original question phrasing;

Main Progress Plan is a plan that covers the entire project. The purpose is to mark the time of start/stop/milestones.

New question phrasing;

To be answered by management. Main Progress Plan is a plan that covers the entire project. The purpose is to mark the time of start/stop/milestones.

- *Adjust the order of questions and to omit irrelevant questions.*

Example:

Original order of question;

Team Plan is a plan for each individual in the team. The purpose is to highlight the coming individual activities.

☐ Exist in the project

Have you participated in the preparation of such a plan?

☐Yes ☐No ☐ Not sure ☐Not applicable

☐ Does not exist in the project

☐ Not sure } proceed to question 4

New order of question, and omissions;

To be answered by workers, supervisors and foremen. Team Plan is an activity based plan on the individual level, developed in the team meeting. The purpose is to highlight individual activities for the coming week.
Have you participated in the preparation of such a plan?
Yes No Not sure Not applicable

The omitted parts of the initial question served several purposes. The new question simplified and shortened the questionnaire. The complexity was reduced to clarify how informants should address the question. The omitted parts, based on a qualitative as-

sessment, did not add specifically relevant data needed to explore the hypothesised relationships.

- *Company adjusted questionnaires will be developed.*

Examples of pair wise concepts that were later adjusted according to company internal uses:

Operations meeting/lookahead meeting
Supervisor meeting/Monday meeting
Collaborative planning/Lean Construction

- *Preventing close-end answer options from being ticked more than once.*

Example:

Original question phrasing;

What is your highest formal education?
Elementary school
Senior high school (upper secondary school), general education
Senior high school (upper secondary school), vocational college without certificate
Etc.

New question phrasing;

What is your highest level of formal education? *Tick only one*.
Elementary school
Senior high school (upper secondary school), general education
Senior high school (upper secondary school), vocational college without certificate
Etc.

Conclusion

Based on the indicative pilot study findings, the suggested triangulation of qualitative and quantitative data collection methods was employed in the main study, subsequent to

minor changes suggested in this report. The findings suggested that the proposed triangulation for the main study was suitable to address the research question in terms of functional relationships between the use of collaborative progression planning tools and improved collaborative main contractor subcontractor relationships, and learning how progression planning tools may be employed to positively influence this relationship.

Appendix C: Interview guide, Part I

Project management's experiences with collaborative planning methodologies in construction projects. A Norwegian case study.

Background variables project:

- Type of construction
- Duration
- Place
- Project value
- Type of contract
- Own share of production

1. Background variables individuals:
   a. Training/follow up/information about collaborative planning
   b. Number of years employed
   c. Number of projects with collaborative planning, including current
   d. Age
   e. Gender

2. Initial phase of projects
   a. Which effects did you expect when you started?
   b. Did you receive any information about collaborative planning before startup?
   c. Did you receive any training about collaborative planning before startup?

3. Investigate the use of collaborative planning among project management
   a. How and to what extent have the collaborative planning methodology been used?
   b. What is being done different now in projects with collaborative planning?
   c. Which elements of collaborative planning have been used in the project? (Which activities have been done?)
   d. Have collaborative planning been used on whole or parts of the project?
   e. Have subcontractors been involved? (all/ the larger ones)

4. Investigate the effects and outcomes of collaborative planning among project management
    a. Describe general experiences with the process of implementing collaborative planning?
    b. What was the main difference from earlier projects?
    c. Have you experienced any benefits (was it helpful?) from using collaborative planning? What kind of benefits?
    d. What is achieved in terms of quality outcomes and measurable effects?
    e. What has been positive and what has been negative?
    f. Did you achieve the expected (or any) qualitative and quantitative effects?
    g. Schedule, budget, quality, HES, job satisfaction)
    h. Why was it effective / not?

5. Investigate future use of collaborative planning
    a. Do you wish to use the collaborative planning methodology again in coming projects? Why/why not?
    b. Which elements of collaborative planning, do you wish to continue using in future projects / not continue with? (Why/not)
    c. Which pitfalls do you see in terms of falling fall back into traditional ways of running projects? Why?
    d. Which barriers exist for future use?
    e. What does it take to use the methodology on the next project?
    f. If collaborative planning is not a desired way to run projects in the future, which arguments are being used to describe why collaborative planning does not fit into the project?
    g. Which are the most important drivers for future use?

Appendix D: Interview guide, Part II

Background information

Can you describe your background in terms of education and experience in the construction industry?

Can you describe your current position?

How long have you been employed by the main contractor?

For subcontractors: have you conducted projects for this main contractor before?

New planning methods and routines

New planning procedures:

Project managers / construction management involved in the production planning

Process of making appointments for next week's activities

The principle of "healthy" activities

Register failure and causes of failure

Direct follow-up in production by the project manager

What is your main impression of how the new planning procedures work?

What works, what does not?

Who are involved in the planning of activities?

Is this different from previous projects?

What are the positive/negative effects of this change?

How does weekly and look ahead planning meetings work?

How active are people in the planning meetings?

Has communication improved as a result of new planning routines?

Sufficient communication?

Communication about what?

Are there conditions that immediately needs to be improved, what, and if so how?

Do you think the new planning practices contribute to increased productivity in the project?
How?

What other important factors affect productivity in your opinion?

Project and production organisation

What do you think about how the main contractor has organised this project?

How would you describe the communication and collaboration within and between the different levels of the project? (project manager, planners, construction management, supervisors)

What is, in your opinion, the main bottleneck in the production?
'Trade collision'
Materials, components
Tools
Crew
Information
Enough space
External relations, such as owner and architect.

What do you think are the main reasons for such bottlenecks to occur, and it is possible to correct them in any way?
Waiting
Errors

How do you view the importance of the order of work?
And the importance of keeping deadlines?

New management roles

For how long have you been a supervisor (project manager, construction / operations manager, planner)?
What do you think are your main tasks as a supervisor?
How do you, as supervisor, divide you working day in relation to:
Planning

Facilitation
Information
Follow-up / quality control

What typically prevents you from performing your duties as a supervisor?

Did your role as a supervisor change in relation to implementing collaborative planning?

What do you need in order to perform your role as a supervisor better?

Project collaborative culture

What characterises the culture in this project?

How would you describe the level of collaboration across disciplines and between different hierarchical levels?
Is this different from previous projects?
What are the effects of collaboration?

How would you describe the overall relationship between you and the other participants (subcontractor/main contractor)

How would you describe the level of conflicts in this project compared to previous projects?
What are the conflicts about?
If less conflicts; what you do think are the main reasons for lower levels of conflicts?

To what extent do you feel that the other participants recognise and take account of your needs in the production process?
Has this changed during the project?
What influenced this process of change?

Meeting Structure and involvement

What type of meetings do you participate in?

What are their intentions?

To what extent have you been involved in the planning processes in this project?

How important is it to be involved?

Who should be involved in progression planning in your opinion?

Would you say that you are more involved in this project?

In what ways have you been involved?

What are the effects of involvement?

Has the increased level of involvement led to more predictability in production?

If yes, what were the most important drivers?

Appendix E: Observation protocol, main study, Part II

1. General impression
2. Who were present?
3. Duration
4. Who leads the meeting?
5. Describe the meeting facilities:
    a. Lunch facilities, meeting room, enough space?
6. Catering:
    a. Is coffee/tea or any food served?
7. Course of action:
    a. Joint planning, according to trades, time period, other?
8. Engagement levels:
    a. How active are the participants?
    b. Are there any disturbances in the meeting?
9. Promises made by any participant
10. Issues of special attention
11. Use of terminology
12. Describe the general atmosphere
13. Are all participants heard?
14. Are there any disagreements? If yes, how are they solved?
15. Are they being solution oriented or problem oriented?
16. Describe the role of the manager in running the meeting
    a. Are discussions structured? In which way?
17. Which time horizon are they planning for?
18. What kind of tools do they use?
    a. Smart board? Design drawings, lists of activities, project management software?
19. How do the participants describe other subcontractors/contractors?

Post-meeting comments by the manager in charge

Appendix F: Collaborative culture survey, Part III

This questionnaire is part of a DBA project to investigate how the use of progression planning tools (collaborative planning, Lean Construction) may help develop a collaborative culture within the construction project. The answers in this survey are given anonymously and will be treated confidentially. Thank you for your cooperation.

1 *To be answered by everyone*. Background variables. Initially in this survey you are asked to give some background information.

1.1 Employed by company:

1.2 Position/role in this project, *tick only one*
Apprentice
Unskilled worker (helper)
Skilled worker
Team Supervisor
Foreman
Progression planner
Operations manager
Site manager
Project manager
Officer
Other *(describe)*:

1.3 How old are you?
Note the age

1.4 Note gender
Male
Female

1.5 What is your highest level of formal education? *Tick only one*.
Elementary school
Senior high school (upper secondary school), general education
Senior high school (upper secondary school), vocational college without certificate

Senior high school (upper secondary school), vocational college with certificate
College with degree
College or university undergraduate degree
College or university graduate
None of the above

1.6 Do you have a master craftsman's certificate, if yes, in which trade?

1.7 How long have you been employed by your current employer?
Note number of years
Less than one = 0 Not sure =99

1.8 How many people are employed by your company?
4 employees or less
5–10 employees
11–25 employees
26–50 employees
51–100 employees
More than 100 employees
Not sure

1.9 Have you previously been involved in projects where collaborative planning was used?
No, this is my first project with collaborative planning
Yes, I have been involved in …projects with collaborative planning

2 This section attempts to map your involvement in the various meetings in the project.
Please tick

2.1 *To be answered by everyone.* The kick-off meeting is a meeting where information is given about the project and about collaborative planning, and where [company A] own employees and subcontractors are usually attending.
Did you participate in a kick-off meeting?
Yes No Not sure Not applicable

2.2 *To be answered by everyone*.
Have you participated in a process planning session with
post-it notes in this project?
Yes No Not sure Not applicable

3 This section attempts to map your participation in various progression planning levels in the current project. *Please tick.*

3.1 *To be answered by management*. Main Progress Plan is a plan that covers the entire project. The purpose is to mark the time of start/stop/milestones.
Have you participated in the preparation of such a plan?
Yes No Not sure Not applicable

3.2 *To be answered by supervisors and management*. Phase Plan is a plan that includes the main phases of the project. It is often developed using post-it notes and the purpose is to show the sequence of activities.
Have you participated in the preparation of such a plan?
Yes No Not sure Not applicable

3.3 *To be answered by supervisors and management*. Lookahead plan is an activity based plan that is an excerpt of the phase plan, developed in the Lookahead meeting. The purpose is to identify and remove any obstacles according to seven preconditions.
Have you participated in the preparation of such a plan?
Yes No Not sure Not applicable

3.4 *To be answered by supervisors and management*. The weekly plan is an activity based plan that is a further detailing of the lookahead plan. It is developed in the supervisor meeting and the purpose is to show the order of activities in the short term, 1 – 2 weeks ahead.
Have you participated in the preparation of such a plan?
Yes No Not sure Not applicable

3.5 *To be answered by workers, supervisors and foreme*n. Team Plan is an activity based plan on the individual level, developed in the team meeting. The purpose is to highlight individual activities for the coming week.

Have you participated in the preparation of such a plan?
Yes No Not sure Not applicable

4 This section attempts to address your experience with “healthy activities” (those are tasks that can be performed without obstacles). *Please tick.*

4.1 *To be answered by everyone*. Do you attend meetings where the term ‘healthy activities’ is used?
Yes No Not sure Not applicable

4.2 *To be answered by everyone*. Do you participate in meetings where you discuss obstacles for future production activities?
Yes No Not sure Not applicable

4.3 *To be answered by everyone*. Do you participate in meetings where you discuss any obstacles that caused previous tasks not to be completed?
Yes No Not sure Not applicable

4.4 *To be answered by everyone*. Do you find that you acquire useful knowledge through discussing and removing obstacles for future production activities?
Yes No Not sure Not applicable

5 *To be answered by everyone*. Do you find that you acquire useful knowledge through discussing and removing obstacles for future production activities? *Please tick.*

5.1 *To be answered by supervisors and management.* Do you have office space on the construction site with other contractors on the same management level?
Yes No Not sure Not applicable

5.2 *To be answered by supervisors and management.* Would you have liked to have a permanent office space on the construction site with other contractors on the same management level?
Yes No Not sure Not applicable

5.3 *To be answered by everyone*. Do the contractors share the same lunch facilities in this project?
Yes No Not sure Not applicable

5.4 *To be answered by everyone*. Do managers and workers share the same lunch facilities in this project?
Yes No Not sure Not applicable

5.5 *To be answered by everyone*. How many times have you in this project participated in joint social events? (During or after work)
Note number of times

5.6 *To be answered by everyone*. Do you feel that your immediate superiors appreciate the job you are doing?
Yes No Not sure Not applicable

5.7 *To be answered by everyone*. Do you feel that the [Company] project management appreciate the job you are doing?
Yes No Not sure Not applicable

5.8 *To be answered by everyone*. Do you feel that the other contractors appreciate the job you are doing?
Yes No Not sure Not applicable

5.9 *To be answered by everyone*. Have you experienced an unnecessary separation (us and them) between various trades and contractors?
Yes No Not sure Not applicable

6 *To be answered by everyone*. This section attempts to address your experiences in the current project. Please specify whether you agree or disagree with the following statements.

In this project,
I find that collaborative planning:

Totally disagree	To some extent disagree	Neither Disagree nor agree	To some Extent agree	Totally agree	Not sure

contributes to contractors working as one team

influences contractors to increasingly work towards a common goal

contributes to closer dialogue between contractors

enables me to be more involved in the construction process

helps us to jointly solve problems at an early stage

contributes to fewer conflicts and blaming/criticism among contractors

contributes to increased job satisfaction

makes me commit to take more responsibility in the project

makes me more interested in other trades' work processes

positively affects contractors to offer a helping hand and to share resources

positively affects the perceived equality among contractors

gives me greater confidence that promises made by other trades are kept

contributes to more structured meetings

contributes to a tidier and more organised site

makes me focus more on improvement and learning

Thank you for answering this survey!

Appendix G: Regression models, Part III

The regression models contained in appendix G indicate significance levels of 1, 5 and 8 percent. 1 percent is marked with ***, 5 percent is marked with **, and eight percent is marked with *.

	Model B
Constant	2.984***
Background variables	
Contractor affiliation	**.205***
Position (workers reference category)	
Supervisors	-.238
Foremen	**-.529****
Project management	.248
Age	
Age categorised	**-.259****
Formal education (elementary school reference category)	
Highschool without certificate	**.567****
Highschool with certificate	**.518****
College with degree	.253
University degree	.344
Years with company (less than two years reference category)	
2–4 years	-.057
5–11 years	-.102
12 years or more	-.126
Company size (100 or more is reference category)	
Four or less	**.714***
Five to twenty five	.066
Twenty six to one hundred	.137
Previous experience	.037
Participation	
Kick-off meeting	.091
Pull schedule planning	-.008
Main progress plan	-.235
Phase plan	**.397***
Lookahead plan	.199
Weekly plan	.011
Team plan	.176
Collaborative discussions	
Discussing healthy activities	.060
Discuss obstacles for future production	.235
Discuss obstacles in previous production	**-.271****
Aquires knowledge from discussions	.055
Relational aspects	
Have office space	-.127
Would like to have office space	.064
Contractors share lunch facilities	.062
Managers and workers share lunch facilities	**.255****
Participated in joint social events	
1–3 times	-.033
4–5 times	.010
6 times or more	.064
Perceived job appreciation	
By immediate superiors	-.061
By project management	.098
By other contractors	**.355*****
Experienced 'us' and 'them'	**-.394*****
R2 adjusted	.217
N	**316**

Appendix table 8. Regression model, Degree of familiarity and common goal setting.
Source: author.

	Model B
Constant	2.917***
Background variables	
Contractor affiliation	.090
Position (workers reference category)	
Supervisors	-.111
Foremen	-.296
Project management	.350
Age	
Age categorised	-.146
Formal education (elementary school reference category)	
Highschool without certificate	.163
Highschool with certificate	.221
College with degree	.027
University degree	-.028
Years with company (less than two years reference category)	
2–4 years	-.028
5–11 years	.080
12 years or more	.085
Company size (100 or more is reference category)	
Four or less	**-.073**
Five to twenty five	.157
twenty six to one hundred	.016
Previous experience	.044
Participation	
Kick-off meeting	.168
Pull schedule planning	-.057
Main progress plan	-.204
Phase plan	.316
Lookahead plan	.122
Weekly plan	-.142
Team plan	.133
Collaborative discussions	
Discussing healthy activities	.201
Discuss obstacles for future production	-.002
Discuss obstacles in previous production	-.062
Aquires knowledge from discussions	.182
Relational aspects	
Have office space	.058
Would like to have office space	.106
Contractors share lunch facilities	.005
Managers and workers share lunch facilities	**.198***
Participated in joint social events	
1–3 times	.058
4–5 times	.112
6 times or more	**-.489****
Perceived job appreciation	
By immediate superiors	.161
By project management	.118
By other contractors	.154
Experienced 'us' and 'them'	**-.242****
R2 adjusted	.212
N	**305**

Appendix table 9. Regression model, Degree of involvement and communications.
Source: author.

	Model B
Constant	2.658***
Background variables	
Contractor affiliation	.173
Position (workers reference category)	
Supervisors	-.262
Foremen	-.421
Project management	.315
Age	
Age categorised	-.126
Formal education (elementary school reference category)	
Highschool without certificate	.336
Highschool with certificate	**.536****
College with degree	.112
University degree	.231
Years with company (less than two years reference category)	
2–4 years	-.065
5–11 years	-.034
12 years or more	.104
Company size (100 or more is reference category)	
Four or less	.362
Five to twenty five	.105
twenty six to one hundred	.110
Previous experience	.073
Participation	
Kick-off meeting	.069
Pull schedule planning	-.178
Main progress plan	-.284
Phase plan	**.589****
Lookahead plan	.246
Weekly plan	.026
Team plan	.049
Collaborative discussions	
Discussing healthy activities	.154
Discuss obstacles for future production	.147
Discuss obstacles in previous production	-.142
Aquires knowledge from discussions	.040
Relational aspects	
Have office space	-.162
Would like to have office space	-.201
Contractors share lunch facilities	.000
Managers and workers share lunch facilities	**.327*****
Participated in joint social events	
1–3 times	.091
4–5 times	.194
6 times or more	-.264
Perceived job appreciation	
By immediate superiors	.212
By project management	.215
By other contractors	.043
Experienced 'us' and 'them'	**-.256****
R2 adjusted	.179
N	**308**

Appendix table 10. Regression model, Degree of conflict (trust).
Source: author.

	Model B
Constant	3.317***
Background variables	
Contractor affiliation	.130
Position (workers reference category)	
Supervisors	-.194
Foremen	-.315
Project management	.211
Age	
Age categorised	-.168
Formal education (elementary school reference category)	
Highschool without certificate	.291
Highschool with certificate	.312
College with degree	.111
University degree	.085
Years with company (less than two years reference category)	
2–4 years	**-.258***
5–11 years	-.216
12 years or more	-.137
Company size (100 or more is reference category)	
Four or less	.341
Five to twenty five	.015
twenty six to one hundred	-.083
Previous experience	.085
Participation	
Kick-off meeting	-.003
Pull schedule planning	.006
Main progress plan	-.214
Phase plan	.023
Lookahead plan	.196
Weekly plan	0.65
Team plan	.050
Collaborative discussions	
Discussing healthy activities	.143
Discuss obstacles for future production	.229
Discuss obstacles in previous production	-.105
Aquires knowledge from discussions	.094
Relational aspects	
Have office space	-.017
Would like to have office space	.000
Contractors share lunch facilities	-.087
Managers and workers share lunch facilities	.147
Participated in joint social events	
1–3 times	.086
4–5 times	.158
6 times or more	-.011
Perceived job appreciation	
By immediate superiors	.071
By project management	**.228****
By other contractors	.078
Experienced 'us' and 'them'	-.159
R2 adjusted	0.89
N	**317**

Appendix table 11. Regression model, Degree of motivation.
Source: author.

	Model B
Constant	3.092***
Background variables	
Contractor affiliation	-.000
Position (workers reference category)	
Supervisors	-.280
Foremen	.279
Project management	.163
Age	
Age categorised	**-.209***
Formal education (elementary school reference category)	
Highschool without certificate	**.404***
Highschool with certificate	.286
College with degree	-.042
University degree	.150
Years with company (less than two years reference category)	
2–4 years	-.154
5–11 years	-.116
12 years or more	-.014
Company size (100 or more is reference category)	
Four or less	.422
Five to twenty five	-.178
twenty six to one hundred	**-.257***
Previous experience	-.062
Participation	
Kick-off meeting	-.116
Pull schedule planning	.002
Main progress plan	-.120
Phase plan	-.035
Lookahead plan	.210
Weekly plan	.074
Team plan	.179
Collaborative discussions	
Discussing healthy activities	**.224***
Discuss obstacles for future production	.051
Discuss obstacles in previous production	.009
Aquires knowledge from discussions	-.064
Relational aspects	
Have office space	-.078
Would like to have office space	.107
Contractors share lunch facilities	.177
Managers and workers share lunch facilities	.046
Participated in joint social events	
1–3 times	.078
4–5 times	.180
6 times or more	-.225
Perceived job appreciation	
By immediate superiors	.023
By project management	**.295****
By other contractors	**.273****
Experienced 'us' and 'them'	**-.300*****
R2 adjusted	0.134
N	**328**

Appendix table 12. Regression model, Degree of awareness of each other's perspectives.
Source: author.

	Model B
Constant	3.218***
Background variables	
Contractor affiliation	.122
Position (workers reference category)	
Supervisors	-.223
Foremen	-.128
Project management	.156
Age	
Age categorised	-.131
Formal education (elementary school reference category)	
Highschool without certificate	.132
Highschool with certificate	.262
College with degree	.075
University degree	.144
Years with company (less than two years reference category)	
2–4 years	**-.295****
5–11 years	**-.253****
12 years or more	-.140
Company size (100 or more is reference category)	
Four or less	.289
Five to twenty five	-.005
twenty six to one hundred	.030
Previous experience	.133
Participation	
Kick-off meeting	-.034
Pull schedule planning	-.080
Main progress plan	**-.415****
Phase plan	.103
Lookahead plan	**.283***
Weekly plan	.178
Team plan	-.057
Collaborative discussions	
Discussing healthy activities	**.217****
Discuss obstacles for future production	.107
Discuss obstacles in previous production	-.037
Aquires knowledge from discussions	.176
Relational aspects	
Have office space	-.200
Would like to have office space	-.013
Contractors share lunch facilities	**.200****
Managers and workers share lunch facilities	.057
Participated in joint social events	
1–3 times	.032
4–5 times	-.013
6 times or more	-.237
Perceived job appreciation	
By immediate superiors	-.169
By project management	**.354*****
By other contractors	.100
Experienced 'us' and 'them'	**-.300*****
R2 adjusted	.144
N	**323**

Appendix table 13. Regression model, Degree of predictable working processes.
Source: author.

Appendix H: BETA-values, Part III

Index	1	High school with certificate	.321
		High school without certificate	.292
		Phase plan new	.219
		Appreciated by other contractors	.219
		Us and them	-.190
		Discuss obstacle previous production	-.167
		Age category	-.161
		Position foremen	-.160
		University degree	.145
		Discuss obstacle future production	.141
Index	2	Position management	.188
		Phase plan new	.172
		High school with certificate	.135
		Participated 6 times or more in social events	-.125
		Us and them	-.115
		Discuss healthy activities	.109
		Participated kick-off	.103
		Managers and workers share lunch facilities	.102
Index	3	High school with certificate	.320
		Phase plan new	.314
		Managers and workers share lunch facilities	.166
		Position management	.165
		High school without certificate	.164
		Main progress plan new	-.133
		Appreciated by project management	.123
		Position foremen	-.121
		Us and them	-.118
		Lookahead plan new	.117
		Position supervisors	-.106
Index	4	High school with certificate	.206
		High school without certificate	.157
		Discuss obstacle future production	.147
		2 to 4 years	-.146
		Appreciated by project management	.145
		5 to 11 years	-.126
		Position management	.121
		Age category	-.111
		Main progress plan new	-.110
		Lookahead plan new	.103
		Position foremen	-.101

Index	5	High school without certificate	.210
		Appreciated by project management	.180
		High school with certificate	.180
		Appreciated by other contractors	.171
		Us and them	-.147
		Age category	-.132
		Discuss healthy activities	.124
		Twenty six to one hundred	-.122
		Position supervisors	-.118
		Lookahead plan new	.103
		Team plan new	.101
Index	6	Appreciated by project management	.233
		Main progress plan new	-.221
		High school with certificate	.180
		2 to 4 years	-.171
		Us and them	-.159
		5 to 11 years	-.153
		Lookahead plan new	.153
		Discuss healthy activities	.131
		Contractors share lunch facilities	.115
		Position supervisors	-.103

Appendix table 14. Beta values.

Source: author.

Use of Progression Planning Tools in Developing Collaborative Main Contractor – Subcontractor Relationships in Norway

Thesis presented as partial fulfillment of the Doctor of Business Administration degree awarded by Edinburgh Business School, Heriot-Watt University.

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