Helsinki University of Technology Construction Economics and Management
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SPECIALIST TASK ORGANISATIONS PROCUREMENT APPROACH FOR RE-ENGINEERING CONSTRUCTION PROJECT PROCESSES

Adekunle Sabitu Oyegoke

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Name of the dissertation

SPECIALIST TASK ORGANISATIONS PROCUREMENT APPROACH FOR RE-ENGINEERING CONSTRUCTION PROJECT PROCESSES

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Opponent(s)	Professor Paul Olomolaiye (University of Wolverhampton)
Supervisor	Professor Juhani Kiiras (TKK Helsinki University of Technology)

Abstract

This dissertation provides a framework for improving owners' contracting strategies through a specialist task organisations (STOs) procurement approach for re-engineering construction project processes. The aim of this dissertation is to develop a procurement system that improves an owner's project implementation process in order to meet the project objectives in terms of time, cost and quality. This study involves the analyses of the construction practices, processes, and procedures, the conditions of construction management (CM) contracts, the review of the theoretical bases, the design of a novel procurement method (STO), its initial validation in terms of the theoretical and empirical validation as well as conclusions and summary. The study reveals interrelationships between contracting practices, processes, procurement routes, payments, and risk allocation. The contracting practices of the USA, the UK, Japan and Finland are used as a frame of reference. The dissertation proposes a task-oriented approach to procurement through the integrated product (task) development, the integrated management and the fragmented execution via task organisations. The application area of the suggested STO route is limited to the project and procurement management of large building projects. The STO route allows an owner's design team to produce an overall design that is used by STOs to produce technical detailed engineering design solutions and project cost estimates. The validation of the suggested STO route has been carried out through the mapping against the organisation theories, the case-questionnaire results and the case study examples. These outcomes support the applicability of the STO. 35 case questionnaires were used to compare the prevailing procurement routes in relation to the suggested STO route. The four case examples provide some additional validation. The suggested merits of the STO route include the shift from only-single-designs and cost-based competition toward more advanced competition based on multiple designs, life-cycle costs, alternative materials, constructability and maintainability. The STO route assumes a modular approach to building design. It allows the use of experts' knowledge in design and construction through their involvement in all project stages.

Keywords: Construction, Finland, fragmentation, integration, procurement, value management

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Finally, I dedicate this endeavour to Almighty GOD, be thy glory, for his mercies on my family and me.

A.S. Oyegoke

20 January 2007

LIST OF ABBREVIATIONS

ACM – Agency Construction Management

A/E – Architect/Engineer

AIA - American Institute of Architects

BQ - Bill of Quantities

BPR - Business Process Reengineering

CM – Construction Management

CMAA - Construction Management Association of America

CMC – Construction Management Contract

CMP – Construction Management Plan

Cp – Conference paper

CS – Construction Schedule

D-B - Design Build

DCF - Discounted Cash Flow

F - Finance

FB&L – Feedback & Learning

FIDIC - International Federation of Consulting Engineers

FM – Facility Management

GC - General Contracting

GC-t – General Contract-traditional

GC-st – General Contract-separate trades

GMP – Guaranteed Maximum Price

ICP – Internal Construction Process, comprising design, documentation, contracting and construction phases

ICT- Information and Communication Technologies

IFMA – International Facility Management Association

ISO – International Standard Organisation

ITT – Instruction to Tenderers

JCT - Joint Contract Tribunal

JIT - Just-in-Time

Jp – Journal paper

KSE - Finnish general conditions for building contracts

LCC - Life Cycle Costing

Lr – Laboratory report

MC - Management Contracting

MIS- Management Information System

MS – Milestone Schedule

M&E – Mechanical & Electrical

O/A - Overall

OECD – Organisation for Economic Co-operation and Development

OT – Owner's Team

PCM - Professional Construction Management

PFI - Private Finance Initiative

PCM – Project Cycle Management

PMI - Project Management Institute

PPM – Project Procedure Manual

PPP - Public Private Partnership

PT – Project Team

ROCE – Return on Capital Employed

ROI – Return on Investment

RMP – Risk Management Process

S&D - Specifications and Design

STO - Specialised Task Organisation

TC – Trade Contractor

TQM - Total Quality Management

UR – Users' Requirements

VA - Value Analysis

VE - Value Engineering

WC – Works Contractor

YSE - Finnish general conditions for consulting contracts

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1 INTRODUCTION

This dissertation was driven by the existing problem in the construction industry, i.e. **owner or client dissatisfaction** in terms of prolonged delivery times, exceeded budgets and the non-attainment of quality standards. Real problems were substantiated by the literature study with the emphasis on contractual responsibilities and risks. Construction investments are generally believed to be expensive. When contractual processes are in disarray, owners' risks become bigger and more likely.

It is obvious that owner dissatisfaction and its links to contracting and procurement processes need to be explored, described and discussed. Hence, the dissertation focuses on the means of reducing owners' investment and contractual risks in construction projects through the re-engineering of contracting processes.

Originally, Latham (1994) recommended the formulation of **effective construction processes** that will result in improved project performance in the UK context. Many studies have proposed integration and partnering, i.e. taking a single point of responsibility in order to avoid fragmentation that is believed to be the root cause(s) of the construction industry's ills (Latham 1994; Egan 1998). However, Cox and Ireland (2002) emphasise that the Latham (1994) and the DETR (1998) reports suffer from inappropriate methodology in analysing the causes of inefficiency in construction procurement as well as choosing the subjective preference for partnering solutions. Readily, some of the flaws in partnering (e.g. the false dichotomy between the points of responsibilities) are well-demonstrated in the repeated formation and the subsequent break-up of project teams when in most cases the fragmented construction is one-off or seldom repetitively embarked upon.

Nevertheless, the Egan (1998) report's **five key drivers of change** are adopted for designing the proposed special task organisation (STO) approach: committed leadership, a focus on clients, integrated processes and teams, a quality-driven agenda and commitment to people. However, integration and partnering of processes will be achieved through fragmented tasks that, in turn, will be carried out by STOs. In the STO approach, a robust integrated management system will ensure that managing the fragmented task-based supply chain results in healthy competition, high specialisation, balanced responsibilities sharing and finished innovative projects in terms of reasonable price, high quality, lower risks and completion on time. The STO route involves specialist task organisations to deliver their complete parts (by integrating design, supply and installation; and maintenance). The extension of CM from the product development point of view provides a solution based on integration in the development tasks (and organisations) and on fragmentation in the execution tasks (and organisations). Procurement routes were chosen as the focal means because they determine contractual processes through all project phases. Procurement routes may also serve as levers for the re-engineering of construction project processes as a whole.

The study logic developed by the author involves an overview of the contracting practices found in the four contexts of the USA, the UK, Japan and Finland. This is followed by the broader analysis of procurement as a contractual framework where relationships, responsibilities, risks, tasks and authorities are assigned to organisations and people. The focus is on procurement routes because they serve as a contractual lifeline or as a framework for programming, design, documentation, contracting and construction modalities, means, methods and techniques in projects (Figure 1).

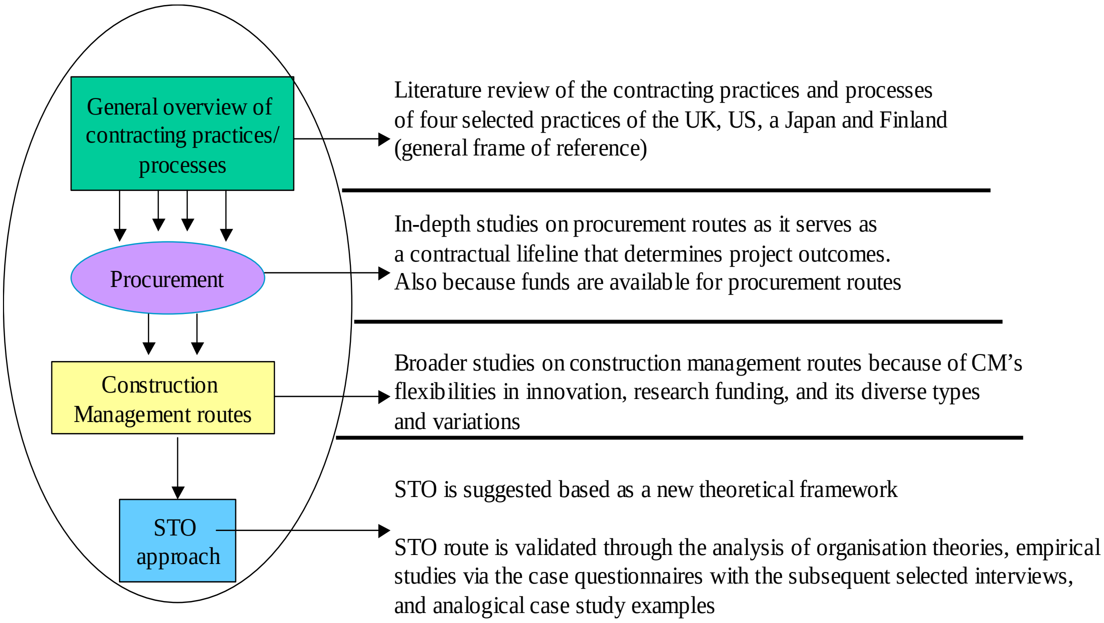


Figure 1 The logic behind the study

This dissertation seeks **to advance procurement routes under CM forms of contracts**. The effectiveness of the proposed STO route, i.e. a robust management system, the integration of product development processes and the fragmentation of project execution processes in solving owner dissatisfaction in construction projects are examined.

Instead of the hypothesis-verification approach, **the constructive approach** is relied upon in this study. The problem is solved through the construction of an organisational procedure. Kasanen et al. (1993) classify the constructive research approach as a type of applied studies that is characterised by the production of new knowledge in a form of normative applications. The approach ties the problem and its solution with accumulated theoretical knowledge.

The constructive research proposition in this study is defined as follows:

Proposition

Integrated management, coupled with the integrated product development process and the fragmented execution process (contracting, design, construction, installation and handing-over) by using specialist task organisations (STOs) to manage/execute the task packages provides a building owner with more flexibility in project processes and enables higher performance in terms of project objectives than alternative procurement routes allow.

1.1 Background and Problems

Adbel-Meguid (1997) refers to the construction industry as **an open organisation** where different components/disciplines are both interchangeable and intervening according to prevailing conditions and to work environments. He further refers to Barrie and Paulson (1992) who address custom-orientation, incentives, and human factors that consequently lead to a fragmented industry in terms of high numbers of project participants, i.e. owners, consultants, statutory authorities and contractors/constructors.

The construction industry is faced with the enormous task of managing diverse interests in order to achieve **owners' project goals**. For example, Junnonen (1998) asserts that the common thinking and/or the behaviour that unite individuals form a business strategy in a given construction firm. Therefore, the major issue of strategy formation is one concerned with how to read the company's collective mind, understanding how intentions diffuse through the organisation and how actions come to be exercised on a collective yet consistent basis. In turn, the building investment strategy of a particular owner and the commencement of its project involve all construction processes and procedures with many organisations. All this begins with an owner's (client's) requirements where the site, environmental and regulatory requirements are being taken into account, followed by the determination of the building design requirements, which again generate the construction requirements.

As procurement methods evolve, collective decision making processes by various professionals at different points in time evolve as well. The functional roles and the participation of professionals depend on involvement in making purchasing decisions. Nowadays, any of primary project stakeholders could individually or jointly initiate projects, secure finances, create programmes and also carry out many of traditional owners' duties. In any case, there must be users for finished projects so that these become financially feasible.

Prior this study, Oyegoke (2004c and 2006a) has compiled **the positive and negative aspects** of the contracting practices of the USA, the UK, Japan and Finland in Table 1. The positive and negative attributes are derived through the theoretical analysis via the reviews of the extensive empirical and theoretical information (literature) on the four practices. The dissatisfaction in project performance among owners is reviewed vis-à-vis the three contracting practices of the UK, the USA, and Finland as follows.

In the UK context, the construction industry has been facing **many severe problems** related to product development processes (e.g. client dissatisfaction), stakeholders (e.g. industry dissatisfaction) and contracting processes (e.g. supply chain problems) as outlined in the Latham report (1994) and supported by the Egan report (1998). Overall, client dissatisfaction is related to late deliveries, exceeded budgets and poor quality among both public and private clients. This is due to the fact that the construction industry rarely provides best value. The Latham report (1994) proposed changes toward a more collaborative culture. Alliances (partnering) all the way through the contract chain were seen to be the most effective way of rethinking the industry. The Egan report (1998) identified the five key drivers of change needed to set the agenda for the construction industry at large: committed leadership, client focus, integrated processes and teams, a quality-driven agenda and commitment to people. All this has resulted in a number of studies proposing **innovative and incentive ways** of carrying out construction projects such as partnering and alliances (Cox and Townsend 1998; Stephenson 1996; Hellard 1997) and effective design management (Gray and Hughes 2001; Ballard and Koskela 1998).

Table 1. Positive and negative aspects of the UK, the US, Japanese and Finnish contracting practices (compiled from Oyegoke 2004c and 2006).

	UK	USA	Japan	Finland
Positive aspects	▪ Cost management process ▪ Engaged trade contractors ▪ Open tendering procedures ▪ Price compet-ition/ cost differentiation strategies ▪ Price and value mechanism as a basis for job commissioning ▪ Fragmented consulting services	▪ Largest heavy engineering market ▪ Homogenous, common attributes; currency, policy, language etc. ▪ Engaged works contractors ▪ Economies of scale due to the large size of the market ▪ Liberalistic tendencies ▪ Clients' interests represented well ▪ Low market barriers to entry	▪ Excellent R&D ▪ Integrated practice ▪ Off-site manufacturing ▪ Engaged specialist subcontractors ▪ No internal barriers or regional differences ▪ State protected industry ▪ Dispute resolution between the boundaries of relationships ▪ ISO 1400 series for environment management is widely in use	▪ Project management prowess ▪ Fewer claims ▪ Industrialised building techniques ▪ User involvement and representative bodies ▪ Clear conditions of contracts ▪ Players' interests represented well ▪ Low barriers to business entry ▪ Flexibility in dispute resolution
Negative aspects	▪ Complex dispute resolution ▪ Too many 'non-value-adding' costs ▪ High documentation and complex conditions of contracts ▪ Complex dispute resolution ▪ Low R&D investments vs. other industries	▪ Too active/ involved lawyers ▪ Contractor up-scale movement restricted by bond requirements ▪ No independent cost managers ▪ Complex dispute resolution ▪ No independent cost consultants ▪ Low R&D invest-ments vs. other industries	▪ Collusion during tender (dango) ▪ Lack of value mechanism/ price competition ▪ No representative body private client ▪ Life-cycle costing not widely used ▪ No independent cost consultants ▪ No formal contracts between contractors and subcontractors	▪ Fragmented management system ▪ Little knowledge on claim management ▪ Small size of the market ▪ Less rigidity in excising contractual penalties ▪ Pioneering life-cycle costing ▪ Some inde-pendent cost consultants ▪ Low R&D investments vs. other industries

Typically, Male and Mitrovic (1999) suggest the outsourcing of non-core activities through the establishment of sourcing alliances in the UK. For instance, the prototype design approach is emerging in order to increase the volume of standard components and to enhance partnering between contractors and suppliers. Similar new approaches save bidding costs, allow co-ordinated bulk materials purchases and provide economies of scale. In addition, industrial owners and utilities (using the opportunity of the deregulated infrastructure market to achieve globalisation) are opting for the 'flash-track' approach by undertaking just-in-time design and construction in parallel (Male and Mitrovic 1999). Private Finance Initiative (PFI) encourages private participation in public sector projects (Akintoye et al. 1998, Cox 2001, Zhang and Kumaraswamy 2001). Shared responsibility in construction management (SR-CM) encourages the CM equity involvement in projects in a form of equity stakes or guarantee trusts by third parties (Oyegoke 2001a).

In the context of the USA, the construction industry is faced with numerous problems among which are the inability to finish on time, on budget, and to meet the expectations of building owners/users (Post 2001 and Post 1998). The key problems of non-performance can be linked with contractual and product development processes. Kashiwagi (2002) proposes best value procurement that uses information systems to minimise risks and to increase performance and efficiency. He promotes a performance-based procurement system known as the Performance Information Procurement System (PIPS), which is a simplified, non-technical and logical process. The PIPS process consists of seven steps as follows: setting up the process and the education, selecting a test project, collecting the past performance information (PPI), submitting and analysing the bids, selecting the best value contractor, minimising the pre-award phase risk as well as implementing the construction works and rating the construction performance.

In addition, Dorsey (2004) deals with the delivery methods involving financing or operations and maintenance of the facility. The resultant effect is an increment in the number of variables such as the consideration for lease rate, the lease duration and the operating expenses that are factored into the evaluation process especially at the stage when the contractors are selected. Dorsey also examined the impact of the financing on the procurement process. The primary driver for third party involvement depends on the owner's knowledge and experience with construction financing as well as the scope for which funding is required.

In the context of Finland, Lahdenperä (1998) has suggested the modification of the operational modes of the construction industry for the common good. He proposed 10 principles that assist in the renewal of the operational modes: a consumer-oriented phased approach, a distinction between the shell and interior of buildings, a performance approach in planning and specification, competition based on implementers' technical solutions, the extended commercial means of competition, the establishment of system units for assigning the scopes of liability, system-unit-skilled teams, industrial component production and the activation of research and development.

Across these three national contexts, it seems that most of new initiatives can be placed under **the umbrella of the re-engineering of contracting processes**. In practice, there are only some landmark breakthroughs. Overall, the problems of owners' dissatisfaction are remaining especially in supply chain management. The temporary and multi-organisational nature goes hand in hand with the fact that buildings are procured before they are built and no two projects are entirely the same. Various task organisations are engaged in the execution of projects. Task organisations establish links among themselves to form project teams guided by owners' managers and by legal and contractual parameters.

Hence, this dissertation is based on **the key premise** that owner dissatisfaction in project performance can be causally linked with contractual and product development processes. In principle, task organisations can contribute to better procurement arrangements via the re-engineering of total supply chain processes. The emergence of management integrators is proposed to solve problems inherent in both integrated product development and fragmented project execution. The second premise is that an innovative understanding of contracting processes results in new and better organisational approaches to design and construction.

Initially, **five core value-adding processes or segments** are put forth as one of new viable solutions for managing contracting processes as follows: (i) better management of users' requirements, (ii) improvement of project financial modalities, (iii) better management of internal construction processes, (iv) improvement of facility and organisational management and (v) effective feedback and learning (Oyegoke 2004e).

1.2 Aims and Limitations

The main aim of this dissertation is to develop a novel procurement method that can be used for re-engineering contracting processes in order to ensure the attainment of owners' project objectives in terms of time, cost and quality. A new STO route is designed in terms of (i) an operational mode, (ii) contractual arrangements, (iii) integrated communication, coordination and cooperation systems, (iv) balanced risk allocation, responsibilities distribution and compensation methods and (v) an integrated value adding project chain.

The theoretical scope of this dissertation covers project-specific contracting processes and focuses on procurement routes as a contractual framework (the points of responsibilities) in construction contracts in terms of processes, parties, procedures, phases and activities. **The application area** of the suggested STO approach is limited to the project and procurement management of large building projects.

1.3 Structure of the Report

The national construction practices (industries) of the USA, the UK, Japan and Finland have been used as a frame of reference in comparing and synthesising procurement routes with the emphasis on CM contracting in order to arrive at the new STO approach as an extension to the current CM forms.

In Chapter 1, the logic for this dissertation is introduced, the aims and sub-aims are defined vis-à-vis this monograph (see Figure 1).

In Chapter 2, the research methodology with its related choices (of the problem, questions and methods) is introduced. The applied nature of the study is determined by combining the theory-based STO route design process and its validation process. The theoretical validation is based on the mapping of the STO route against the selected organisation theories. The empirical validation is qualitatively based primarily on the project case questionnaires complemented by some interviews and by case study examples.

In Chapter 3, the comparison and synthesis of five procurement routes in the three national contexts of the USA, the UK and Finland were carried out. The broader comparative analysis was conducted targeting the CM routes within the frame of reference.

In Chapter 4, the new STO approach is designed and introduced in terms of its operational mode, contractual arrangements, integrated communication, coordination, and cooperation systems, balanced risk allocation, responsibilities distribution and compensation methods, the integrated value adding project chain and some constraints.

In Chapter 5, the suggested STO approach is validated theoretically (against the selected organisation theories), empirically (the project case questionnaires) and analogically (the four descriptive project case study examples). The conclusions are made accordingly.

In Chapter 6, the conduct and findings of the study are summarized, the study's contribution to the pile of cumulative knowledge on contracting and procurement is specified and the areas for further studies are highlighted.

2 RESEARCH METHODOLOGY

Herein, the research methodology with its justifications is presented. This methodology was designed to suit (i) the targeted research questions/problems, i.e. how to improve owners' (clients') project satisfaction level via procurement and (ii) the author's practical limitations.

2.1 Generic and Construction-related Research Approaches

The generic and construction-related research approaches are dealt with to set the arena. However, the key principles of the constructive research approach of Kasanen et al. (1993) are selected to guide the conduct of the concept design process and the 3-part validation processes as follows.

The normal sequence in carrying out research work is to define problems and learn surrounding facts that can result in a better understanding of targeted problems. A researcher can devise her or his own workable methods as far as a reasonable, logical and convincing explanation can be given to support this approach. It is the responsibility of a researcher to choose a model or a strategy that both fits the problem to be solved and/or fits other research objectives, and that will produce reliable results (Bell 1999). Any piece of research must have a stated scope and limitations, as a single research project cannot solve all problems associated with a given study. A good piece of research should conclude with a discussion based on actual findings.

The type of research question and a degree of control a researcher has over the implementation of tools and techniques determine in large part the strategy to be adopted in carrying out the study. An extent of control an investigator has over the actual behaviour of events and a degree of focus on the contemporary as opposed to the historical events are key conditions for the use of a particular strategy (Yin 1989).

A research strategy may include an experiment, a survey, an archival analysis (e.g. economic study), a history and a case study. These strategies answer questions on why, who, where, how, what and when (Yin 1989). Qualitative research involves many relevant ways of exploring and describing, explaining and predicting, ordering and explaining as well as drawing conclusions and verifying (Miles and Huberman 1994).

In general, **a research design** consists of five interrelated aspects: what is the aim or purpose is, what theory informs the study, what research questions are to be posed, what method is employed in the collection of the data and what is the sampling strategy of the data (Robson 2002). The question-driven research design is a logical sequence that connects the empirical data to a study's initial research questions and, ultimately, to its conclusions. The aim of the research design is to guide a researcher in the process of collecting, analysing and interpreting the data as well as to avoid situations where the evidence does not address the initial research questions (Yin 1989). Qualitative and historical studies are seen as making a valuable contribution to research, while comparative and quantitative studies provide a distinct, complementary addition to knowledge (Donaldson 1988).

The current construction-related research approaches in the literature are briefly reviewed as follows. Construction-related research is used to define and solve problems, as well as to improve an existing system or performance, with the overall implication of adding to the existing body of knowledge. Pure and applied sciences have their places in construction, as construction work involves different processes and procedures on both demand and supply chains. This broadens complex construction-related research so that it demands multidisciplinary thinking and actions. Research, therefore can be of many types: some are focused strongly on scientific experimentation and discovery, while others might be pursuing behavioural questions (Fellows and Liu 1997).

There has been a great deal of debate in assessing the most appropriate research methodology for construction-related research problems. Walker (1997) provides **six criteria** for a well-developed research project: novelty, state-of-art knowledge of the subject, identification of gaps in current knowledge on the subject, a grasp of research techniques and their limitations, well-communicated results and the internationalisation of the work for wider credibility.

Wing et al. (1998) argue that the choice of a research approach in CM depends on **the nature of a given problem**. They profess further that the problem and the associated key concepts be defined clearly and the methods used, the underlying assumptions and the limitations be transparent and defensible. Therefore, the choice of a research approach in CM should aim at generating practical solutions.

In turn, Love et al. (2002) postulate that the methodology that dominates the CM research field involves **the interpretivist (phenomenological) and positivist approaches**. The interpretivist approach is based on empiricism i.e. philosophical beliefs formed around the idea that favour experience rather than reasoning. The approach uses practical or experimental methods rather than applying or developing theories, or assuming guiding principles. They postulate further by referring to Hughes (1980) that the positivism approach places emphasis on facts as distinct from values or meanings, with the use of scientific methods in which a theory is deduced as a result of formulating and testing hypotheses. Therefore, Love et al. classify CM research as the intersection of natural science (independent sequence of facts) and social science (thinking of participants).

Herein, **the constructive research approach** (Kasanen et al. 1993) is applied to the phasing of this study as follows. (i) Both the targeted problem of owners' dissatisfaction and its causal roots in construction processes are approached through (ii) the design of a construct, i.e. a new procurement route. The problem and its solution are based on (iii) accumulated theoretical knowledge on contracting and procurement methods as well as contextual knowledge on the current practices in the four countries. (iv) The novelty and actual working of the new STO route are also demonstrated, i.e. the potential usability of the STO is demonstrated through a 3-part validation process. Accordingly, the study has been conducted through the following steps:

- Finding a practical relevant problem that has a research potential. This practical relevant problem of owners' dissatisfaction is outlined in Chapter 1.
- Obtaining a general, comprehensive understanding of the topic. This under-standing of the construction procurement and contracting processes is achieved through the comparative review of the relevant literature in Chapter 3.
- Innovating, i.e. designing a new construct. This novel STO route is put forth in Chapter 4.
- Demonstrating that the new construct (solution) works. The results of this 3-part validation process of the suggested STO route are presented, summarised, discussed and concluded upon in Chapter 5.

- Showing the theoretical connections and the research contribution and examining the scope of applicability of the STO route. These closing aspects are dealt with in Chapter 6.

2.2 New Concept Design and Validation

2.2.1 Design of the STO route based on the broad literature synthesis

The design of the STO route is based on **an in-depth interpretation and synthesis** of the contextual literature on the primary CM-related contracting and procurement routes, practices and processes in the USA, the UK and Finland. This extensive literature reviews enabled the author to gain a thorough pre-understanding of the targeted phenomenon. The proposed STO route is designed and elaborated from many perspectives found in the literature (see Chapter 3) in terms of (i) the attainment of project objectives such as finished product quality, time and costs, (ii) an operational mode, (iii) contractual arrangements, (iv) integrated communication, coordination and cooperation systems, (v) balanced risk allocation, responsibilities distribution and compensation methods, (vi) the integrated value adding project chain and (vii) some constraints.

2.2.2 Validation of the STO route

Obviously, the highly relevant method to test the proposed STO route is via a pilot case study. Regrettably, it turned out that a pilot case study was not a realistic means in the case of this dissertation. Hence, the alternative approach was adopted based on triangulation. In general, there are **four triangulation types**: (i) data source triangulation when the data is expected to remain the same in different contexts, (ii) investigator triangulation when the same phenomenon is examined by several investigators, (iii) theory triangulation where investigators with different points of view interpret the same results, and (iv) methodological triangulation where several approaches are utilised in order to increase confidence in the interpreted and synthesised concept (Feagin et al. 1991 and Stake 1995). In turn, Yin (2003) postulates that the reliability of studies can be improved with multiple sources of evidence.

Herein, the validation process of the STO route has been based on **the methodological triangulation approach**. According to Miles and Huberman (1994), multiple approaches allow the same phenomenon to be viewed from different angles simultaneously. The purpose of triangulation is to increase the reliability and validity of the conceptual research, i.e. the proposed STO route as the new concept is not merely random, since it has been produced by utilising several approaches with interrelated feedback loops to increase the theoretical and practical relevance of the STO route.

The 3-part validation of the STO route consists of the theoretical validation (mapping the STO route against the selected organisational theories), the empirical validation (project case survey/questionnaires), and the analogical validation (case study examples) as follows.

2.2.2.1 Theoretical validation against organisational theories

The theoretical validation was carried out **by mapping the STO route and its elements against the selected organisational theories**, i.e. the organic theory and the bureaucracy theory since procurement routes are directly related to project organisation setups and interaction between their differentiated parts. Aligning with Eisenhardt (1989), it is argued that by examining the divergent literature for seeking possible contradictions and their explanations, one can pre-empt criticism and increase confidence in the study at hand. The organisation theories, both for and against fragmentation and integration, are juxtaposed with the key project procurement routes including the proposed STO route. The mapping allows for an assessment of the level of formalisation, centralisation, functions, control and specialisation within both each of the prevailing routes and the STO route.

2.2.2.2 Empirical validation with the project case survey

The empirical validation of the proposed STO route was carried out in the form of **a project case survey with the subsequent interviews** in order to find out the perceptions of the respondents directly engaged in relevant project cases and, at minimum, the STO-like routes. **The target population of respondents** involves experienced clients, consultants and contractors in the building sector in Finland. Finland was chosen due to the author's location and his access to both local respondents and project documents. In addition, the characteristics of the Finnish procurement systems turned out to be very similar to the practices within the two exemplary countries, the USA and the UK (Oyegoke and Kiiras 2001).

The project case survey was designed to measure the practical relevance and the likelihood of using the STO route in real building project settings. The aim of the survey was to probe some recent cases of the key procurement routes and to reveal the actual project performance, ex post. Initially, the author developed a questionnaire only for addressing the STO route. This STO questionnaire was later abandoned due to a lack of responses. Thereafter, the author formed an alliance with the on-going study on design management systems for concurrent CM projects (the FinSUKE project) at the Laboratory of TKK Construction Economics and Management. The STO questionnaire was **modified** to accommodate the FinSUKE research questions.

The project case questionnaire was designed with multiple views and parts in order to collect the qualitative and quantitative data as well as the factual information and subjective understanding from among the targeted practitioners. Hence, the questionnaire was divided into **six parts** as follows (Appendix 1): (1) General respondent information, (2) project description, (3) project parties and processes, (4) project schedule, (5) design and engineering and (6) project parties' relationships and project performance. The final questionnaire contained neither the particular introduction of the STO route, nor the specific STO related questions.

The trial questionnaire was translated into Finnish and piloted among five Finnish professionals (2 scholars, 2 consultants and 1 contractor). The additional verification was carried out in the form of **follow-up interviews** in order to have first-hand information from many organisations, individuals, projects and procurement methods. In general, there are three qualitative interview types, i.e. structured, semi-structured and unstructured. In a structured interview, the same question types and the given alternatives (by using the same words) are asked in the same order among the interviewees. In a semi-structured interview, the topics, the sample sizes, the interviewees and the questions have been determined beforehand. An unstructured interview has no predetermined set of questions: both interviewer and interviewee interact freely (Rogers and Bouey 1996, Ghauri and Gronhaug 2002).

Herein, **semi-structured interviews** were used in order to probe further and to clarify some of the key issues inherent in the questionnaires as well as to obtain the additional relevant information. The questionnaires were analysed and sent back to the interviewees for modification in order to eliminate the risk of any misunderstandings. Thus, the clarifications and the changes were made in some questionnaires before the data were used for the analysis.

2.2.2.3 Analogical validation with the four case study examples

The analogical validation was relied upon to complement the overall validation of the STO route along the principles of triangulation. In the absence of pilot projects, the analogical validation was carried out in the form of **a review of the existing project case surveys**, i.e. this particular kind of literature. Especially, if any review-generated evidence reveals differences in achieving project success between the STO route and the other procurement routes, the author then can only infer **an association between the higher success and the particular concept(s)**. This is so because review-generated evidence cannot rule out other variables confounded with the study characteristics of interest as possible true causes. Only primary source-generated evidence based on empirical or experiential research allows one to make statements concerning causality. Thus, only the existence of the explicit (implicit) relations can be recognized within the secondary data (Cooper 1998). Likewise, the validity criteria inherent in the case study research, i.e. reliability as well as construct, internal and external validity (Yin 1989 and 2003) are not applicable in the case of this review of four project case study examples.

Herein, **the studies of four building project cases** were selected. The project cases are independent from one another in terms of the project stakeholders, the task organisations and the implementation processes. However, the common features of three project cases were of those having the same owner, the same institutional project type and, in part, the same owner organisation. The four project cases have been executed in Finland between the years 1997 and 2004. The four original project case studies (references) seem to be **in part descriptive and in part explanatory**. The primary authors have produced the references (Pernu 2000 and Salmikivi 2005) based on the action research, i.e. the documentary evidence and unstructured interviews. Originally, the project cases revealed important variations in the focal constructs.

3 COMPARATIVE REVIEW OF PROCUREMENT ROUTES

This chapter compares procurement routes within and between different practices. It examines different type of routes along different practices. The result is synthesised and categorised as both differentiated and integrated procurement classifications. The aim is to provide a wider platform for understanding procurement types, their relationships, and their similarities and differences before a deeper analysis of CM route is undertaken. A set of the broader and deeper comparative analyses of the CM routes along different practices were carried out in terms of responsibility distribution and risk allocation. The effectiveness of the CM types in both risk allocation and risk management is analysed through the use of the CMAA and JCT documents.

3.1 Project Delivery Systems

This subchapter examines the terms and the diversity among the different procurement and delivery methods. It describes the owner's procurement strategies from project inception to completion, the weaknesses of the prevalent routes and the most important issues that shape a given procurement route.

Various authors have used **the terms of procurement methods and delivery methods** to describe ways in which responsibilities, authorities, risks and sometimes payment modalities are arranged in relation to project execution. Procurement deals with a strategy of how owners procure the services of both consultants and contractors for executing their projects. Procurement sets out responsibilities, roles and relationships as well as the allocation of risks among individuals, organisations and companies. Consultants and contractors use many delivery methods to meet owners' project goals and requirements such as quality, speed, budget, flexibility, buildability and accountability (e.g. Skitmore and Mardsen 1988, Chua et al. 1999, Alhazmi and McCaffer 2000 and Cheung et al. 2001).

The diversity among project delivery systems can be attributed to the fact that a construction project organisation has a multi-organisational structure that involves many layers, levels, units and sub-units of organisation. This is so because there are many different design solutions, construction methods and techniques, components, elements, fittings and tasks on a project-by-project basis. The need arises to locate and adequately define organisational boundaries through a clearly defined contractual arrangement in order to prevent inefficiency. Disputes and project failures due to both social and technological changes have weakened traditional boundaries. The significance of technological advancement in both construction services and products has opened up a range of sourcing possibilities from that of purely independent transactional price-based interactions via highly interdependent relationships to one of dependent sourcing (Cox and Ireland 2002). Typically, **Love et al. (1998)** define procurement as an organisational system that assigns specific responsibilities and authorities to both people and organisations, and defines the relationships of the various elements in the construction of a project.

Clients' procurement strategies begin with buying, lease or build decisions after space requirements have been certified. In the case of "build" decisions, project organisations are assembled for project-specific developments. Clients need to establish **contractual frameworks** for determining relationships inside project teams as well as for assigning risks and responsibilities among parties, serving as links between project participants (inter-firm coordination). Arguments for engaging a consultant rather than a contractor as a client's main adviser are inconclusive. Success or failure of any contractual arrangement is heavily dependent upon performance, trust and co-operation among the parties (Dorsey 1997). Contractual arrangements are made for both the specificity and detail of the selected procurement route, e.g. tendering procedures, forms and placing of contracts.

Two major weaknesses of the prevailing procurement systems involve those inherent in the systems and those caused by changes in the environment (Atkins and Pothecary 1994). These weaknesses affect the choices of supply chains for projects: a single contractor (single point of performance responsibility) or multiple suppliers (multiple points of performance responsibilities) that are integrated or fragmented or a mixture of different solutions. Negative consequences involve litigations, additional costs, wastage, delays etc. Hence, new procurement systems i.e. design and build, design and manage, project management and client trustee permitted the separation of the concept design and the delivery of the construction product (Atkins and Pothecary 1994).

Further, **the most important issue in managing procurement routes** is one regarding how risks are distributed, responsibilities are allocated, works are divided, schedules are planned, and compensations and payments are structured. There is no single best procurement route for all project circumstances, and the complexity and the diversity is revealed via the developments of the different national procurement routes and practices. In turn, many incentives and financing instruments add more complexity such as cost plus arrangements and Private Finance Initiative (PFI) in the UK context. In Figure 2, this complexity of the industry is illustrated in terms of total activities in a typical building project. It begins with many stakeholders, tasks, stages, documents, procurement routes, price-determinant factors and determination methods. Further, the type of the procurement method determines the contract form, which may be either through competition or negotiation (determinant factor) in selecting a contractor for the task at hand. Price determinations are used individually or as a combination to enhance productivity, to redistribute risk and to reallocate responsibilities.

3.2 Classifications of Procurement Routes in Four National Practices

This section examines the classifications of procurement routes and compares them along the four national practices of the USA, the UK, Japan and Finland. The Japanese practice is included in order to enlarge this comparison via a country with many unique market traits, relational influence, technological advancement and a strong global position in the international construction market. However, the fairly limited treatment of the Japanese construction practice is due to a lack of recent relevant references published in English.

There are many fairly converging national classifications of procurement routes (and their types) as follows. **In the USA,** there are several basic delivery systems such as single and multiple prime contracts, designer-led lump sum, owner-builder, design-build, design-bid-build, turnkey, CM-at-risk and CM-for-fee, design-manage, project/program management contracts with their many variations and hybrid forms (Franks 1990, Poage 1990, Yates 1991, Barrie and Paulson 1992, Dorsey 1997, Seeley 1997, Konchar and Sanvido 1998 and Haltenhoff 1999).

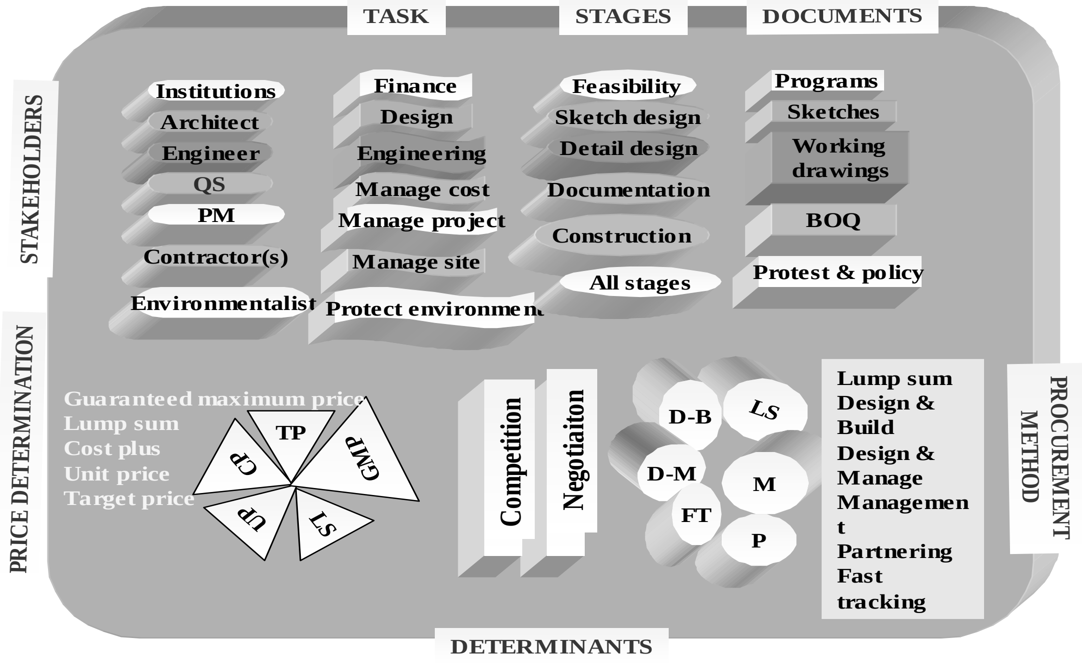


Figure 2. Total project activities from inception to completion

In the UK, there were four main procurement routes in the early 1990s, i.e. general contracting, design-and-build, management contracting and construction management (Corning 1991). Some classifications follow the sequential work processes, the contracting parties and the compensation methods. For example, **Mohsini's (1993) classification** follows the sequence of procurement options (design/bid/build), the dominant contractual framework (design/build, turnkey), the centralised control of processes (management-oriented, integrated and co-operative) and the organisational variables affecting performance (PFI, BOOT). Its weakness is the inclusion of cost-driven contracts and tendering methods as procurement methods. In addition, design/ manage is categorised under management oriented types while also being the major part of the traditional method (the architect designs and administers construction).

In turn, **Masterman's (1992) classification** is broad, including a separated and co-operative procurement route (the traditional system plus many varieties), an integrated route (turnkey, owner-build), a management-oriented route (agency, at-risk). **Along separated and cooperative routes**, there are multiple points of (performance) responsibilities and risks. Design responsibility is placed on separate organisations. An owner contracts designers to produce design documents that are used to solicit fixed price bids (lump sum) from contractors. One contractor is selected to enter into an agreement with the owner to construct a facility in accordance with the plans and specifications. Usually a subcontractor has a direct legal relationship with a construction contractor. **Along integrated routes,** design and construction is the responsibility of a single construction contractor (the single point of performance responsibility). The portions of responsibility for designs and specialised works are subcontracted to other firms, although there is a variety of design and build forms (Akintoye 1994).

Along management routes, management consultants or contractors are involved usually in an agency capacity. An agency agreement between a management firm and an owner may cover partial or full responsibility in contracting services, construction co-ordination, project management and construction administration. The other points of responsibility include design, construction etc. Therefore, this route is termed as the multiple points of responsibility.

In Japan, construction is procured primarily on a design and build basis for a fixed lump sum price, with a contractor providing a complete (‘turnkey’ style) package for a client. The overall scope often includes feasibility and design services and possibly the procurement of a suitable site (Kudo 1999 and Ministry of Construction 2000). Larger clients tend to have in-house professionals to facilitate procurement processes while the smaller ones rely entirely on the expertise of contractors. Although the project setup looks like a design and build, in reality this route is a fragmented process because of the division of responsibility after the design competition (Kudo 1999). Recently, the Japanese Ministry of Construction (2000) asserted that CM contracts have also been adopted at least in foreign firms' projects in Japan in the late 1990s.

In Finland, procurement routes are defined by estimating the scope of the responsibilities in a given building project between a contractor(s) and a client. A client decides which procurement route will be used or how risks will be divided. Common routes are main contracts with nominated sub-contracts, separate trades contracts with a project manager, design-and–construct contracts as well as CM contracting contracts and CM consulting contracts (Pernu 1994, Kiiras et al. 2002).

This comparison of four national practices revealed that design–bid-build procurement routes have maintained a lead in the number and the value of contracts in the USA, Japan and Finland by the early 2000s. Design-and-build and management routes have also made significant gains. This status quo means fragmented construction in the USA, Japan and Finland. In the UK, (i) integration is rising under design-and-build contracts with the high values/volumes of contracts and (ii) fragmented management routes also are evolving. In Figure 3, the positions of the procurement routes are compiled by the numbers and the value of the contracts in both the UK and Finland.

3.3 Comparison of Five Procurement Routes

This section compares five basic routes in the three practices of the USA, the UK and Finland. The comparison follows the fragmented and integrated procurement classifications and the points of performance responsibilities. The aim is to inter-relate the routes along practices and to provide a platform for understanding the position of CM routes better.

In the USA, **fragmented design/bid/build routes** are traditional, i.e. each owner contracts separately with both a designer and a contractor. An owner normally contracts with a designer to provide ‘complete’ design documents (Konchar and Sanvido 1998). In both the UK and Finland, various designers are engaged based on their professional speciality. An owner or an owner’s agent usually solicits fixed price bids from construction contractors to perform works. One contractor is usually selected (with a chain of subcontractors). Haltenhoff (1999) termed this form as general contracting in the US practice, while Seeley (1997) and Dorsey (1997) referred to the same approach as a lump sum contract in both the UK and the US practices.

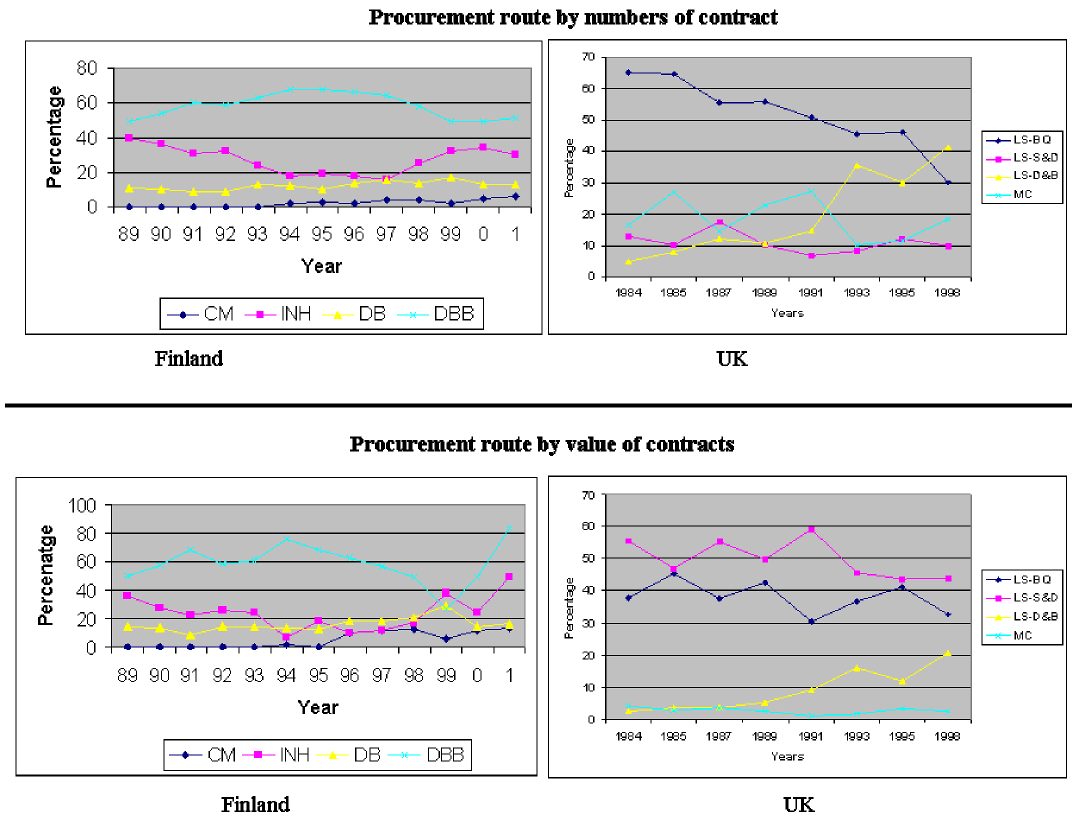


Figure 3. Procurement routes by the numbers and the value of the contracts in the UK in the years 1984-1998 and in Finland in the years 1989-2001

Integrated design-build routes are project delivery systems where an owner contracts with a single entity to perform both design and construction under a single design-build contract in various national practices. In turn, a D-B entity subcontracts portions to other companies (Konchar and Sanvido 1998, Sanvido and Konchar 1999 and Haltenhoff 1999).

Among **fragmented management routes,** agency CM routes consist of multiple prime contracts: (1) an agency contract between an owner and an A/E, (2) an agency contract between an owner and a CM agent and (3) several independent contractor contracts between an owner and trade contractors in the US practice (Haltenhoff 1999). Similar routes are called construction management contracting (CMC) in the UK. In turn, CM-at-risk routes involve an owner who contracts separately with a designer and a contractor. The latter has a significant input in a design process. An owner contracts with a designer to provide a facility design. An owner also selects a contractor to perform CM services and construction works for a fee (Konchar and Sanvido 1998).

In Figure 4, **the points of (performance) responsibility** are illustrated in relation to project parties along three typical procurement routes. Both direct and secondary relationships with clients (owners) occur due to interaction between project parties. In traditional procurement, there are six main (multiple) points of responsibility in a supply chain in regard to liabilities and risks. In D-B contracting, a contractor accepts all responsibilities for a project (Akintoye 1994). In agency CM, there are multiple points of responsibility depending on the division of a work scope used for trade contracts.

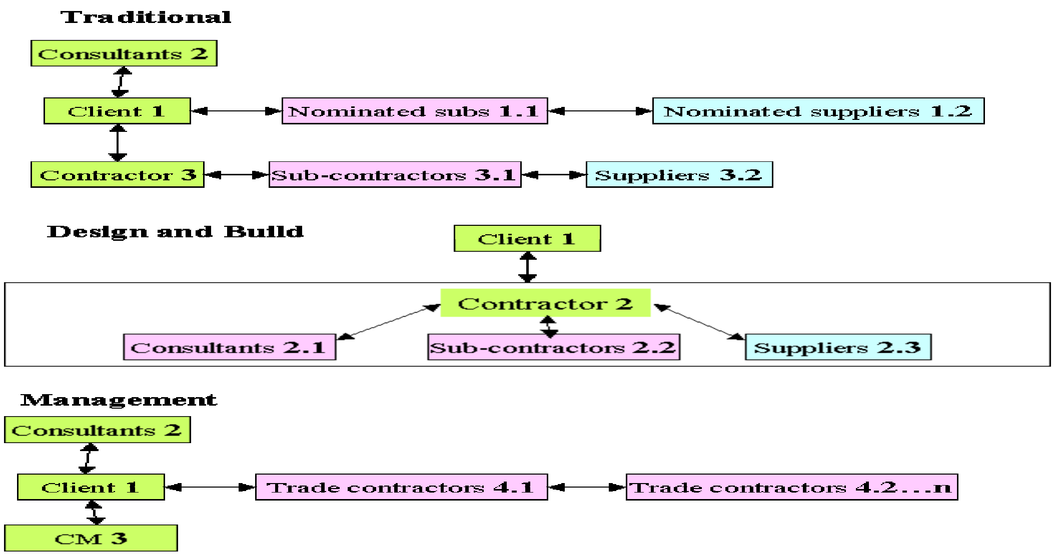


Figure 4. Points of responsibilities within three procurement routes

Overall, Oyegoke and Kiiras (2001) have synthesised **the five basic procurement routes** within the UK, US and Finnish practices as follows: agency CM/CM consulting, at-risk-CM/CM contracting, MC management contracting, traditional contracting and D-B contracting. This classification reveals the key differences in the task and responsibility divisions among project stakeholders such as the differences between CM-for-fee consultants (ACM/CMC) and risk-taking CM contractors (Table 2).

Table 2. Responsibility allocation in five procurement routes

Theme	Fragmented				Integrated
	ACM/CMC	At-Risk CM	MC	Traditional	Design and Build
Briefing	O	O	O	O	O
Design	AE	AE	AE	AE	D-BC
Project management	CMa	CMc	MC	PM	PT
Contracting	O	CMc	MC	QS	PT
Construction works	TC	CMc	WC	GC	D-BC
Project co-ordination	CMa	CMc	MC	AE	PT
Project supervision	CMa	CMc	MC	AE/QS	PT
Construction administration	PT	PT	PT	AE	AE
Scheduling	CMa	CMc	MC	AE/QS/GC	PT/D-BC
Performance	O/TC	CMc	O/WC	GC	D-BC
Safety	O	O/CMc	O/MC/WC	O/GC	O/D-BC
Quality	CMa/TC	AE/CMc	MC/WC	GC	D&BC
Payments	O	O	O	O	O

ACM: *Agency CM;* ***D&BC:*** *Design & Build Contractor;* ***QS:*** *Quantity Surveyors;* ***GC:*** *General Contractor;* ***MC:*** *Management Contractor;* ***O:*** *Owner;* ***AE:*** *Architect/Engineer;* ***PT:*** *Project Team;* ***TC:*** *Trade Contractors;* ***WC:*** *Works Contractors;* ***CMa:*** *Construction Manager agency;* ***CMc:*** *Construction Manager constractor; PM: Project Manager;*

Each project responsibility is assigned to one of the stakeholders in question or shared by two stakeholders or jointly managed by a project team. Risks are assigned to and managed by the principal stakeholder that has the largest contribution per task (e.g. construction works and related risks are assigned to the different contractor roles). In comparison of the definitions of five procurement routes, general and D-B contracting routes make use of a single prime contractor that is hired as an independent contractor. CM and MC contracting exploit multiple prime contractors hired as independent contractors. General contractors (GC) have financial stakes in construction phases under design-bid-build contracts. D-B contractors have financial stakes in both design and construction phases under D-B contracts.

In Figure 5, the additional comparison exposes the similarities and the differences theoretically among the six common procurement routes based on **the points of price competition and those of contractual co-operation**. Contractual co-operation is the primary determinant factor when an owner (client) selects project consultants while price competition serves as the primary determinant along all the six routes. In other words, contractual relationships between an owner and contractors and between contractors and subcontractors as well as among sub-contractors themselves are based primarily on price competition while contractual co-operation serves as the minor determinant somewhere inside the six routes.

Overall, **the variation and hybrids of all the five procurement routes** depend on the compensation structure, the assignment of responsibilities as well as the allocation and distribution of risks between stakeholders combined with particular project characteristics, in each case.

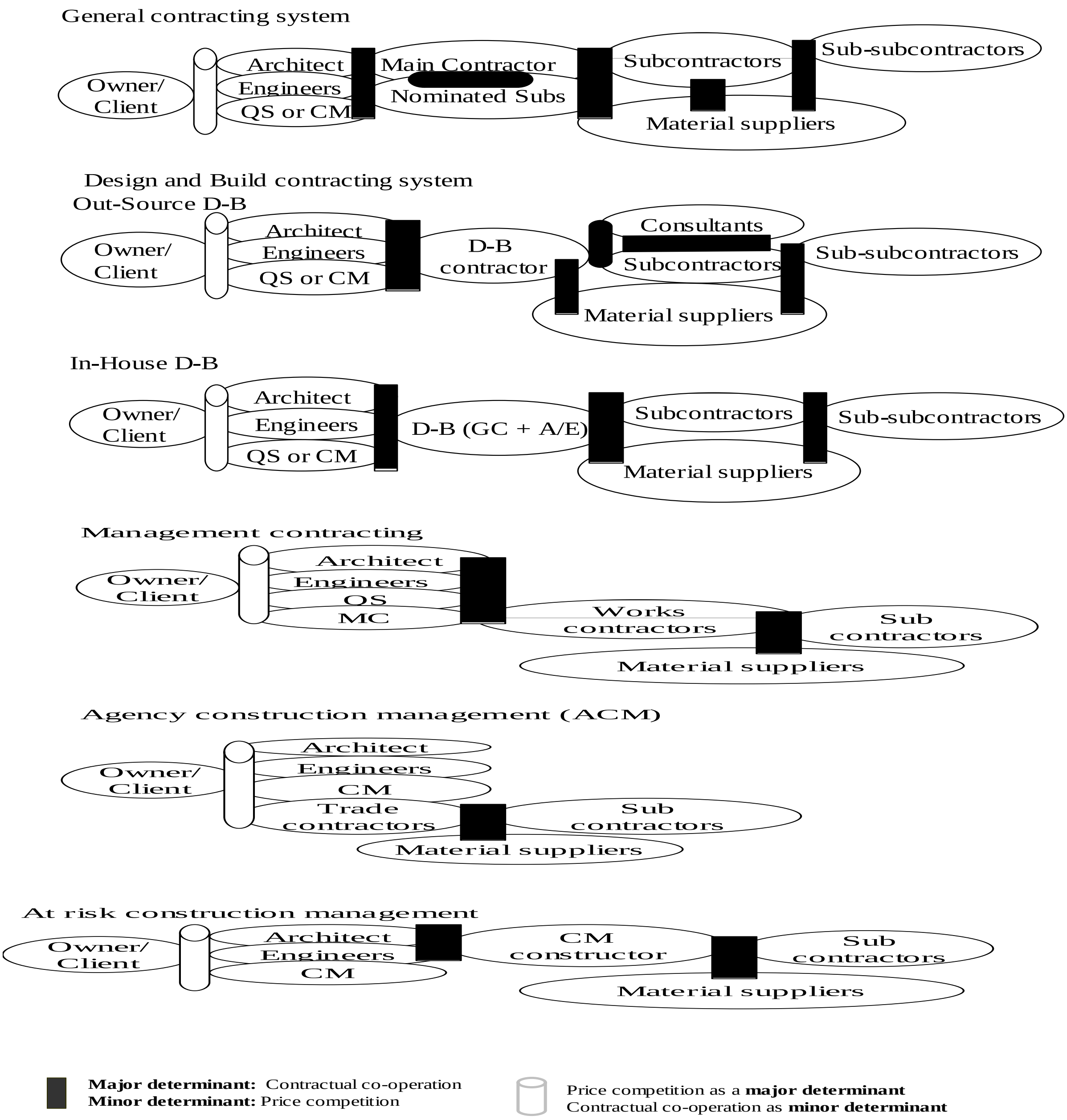
3.4 Broader, In-depth View of Construction Management Contracting Systems

This section provides a framework for comparing CM contracts in the three national practices of the USA, the UK and Finland. This broader, in-depth view of CM routes forms a basis for designing the STO route. The section explores CM types, processes and procedures as well as similarities and differences within and between the practices. CM routes are herein classified as CM consulting and CM contracting. The effectiveness of CM routes in risk allocation and management is demonstrated via the CMAA and JCT documents. Finally, the important issues of claims, compensation and payment modalities and contingency sum are discussed in relation to CM routes.

3.4.1 Three national CM contracting systems

3.4.1.1 CM contracting in the USA

Originally, CM was considered a variation to cost plus contracts involving consulting in development and management in construction in the 1970s in the USA. **The early advantage** of the CM is that owners' interests are also construction managers' interests and works are subcontracted piecemeal with owners participating in procurement. Probable work costs are budgeted and monitored by experienced people. Alternatives can be selected even to influence projects' economy, i.e. long lead time items are designed and purchased early (Bush 1973). Today, CM tasks span across planning, design, construction and post construction in co-operation with owners and designers for the attainment of owners’ project goals. Since most clients do not have sufficient expertise, **the services of CM firms are employed on a fee basis** (Dorsey 1997).



QS – Quantity Surveyor; **CM** – Construction Manager; **D-B** – Design and Build; **GC** – General Contractor; **A/E** – architect and Engineer; **MC** – Management Contractor;

Figure 5. Price competition and contractual co-operation as the primary determinants along the five basic procurement routes

CM is defined as **a discipline and a management system** created to promote the successful execution of projects for owners. The primary consideration is whether the construction manager (a) performs an administrative role acting primarily as an agent to an owner or (b) takes on the responsibilities of a constructor, perhaps working for a GMP (CMAA 2002). Thus, CM is practiced in **two general forms**: agency CM and or

CM-at-risk. In Table 3, the 2-form classification is derived from the theoretical analysis of forms of CM contracting based on the literature reviews.

Table 3. Types of CM contracts in the USA.

Basic forms	Types/ hybrids	Construction Manager's role	Trade Contractors	Sub-Contractors	Price risk/ determination	Project time
Agency CM or CM for fee (CM acting as a consultant)	Pure Agency	Preconstruction services and administering trade contractors	Held by the Owner	-	Owner's risk; C+fee, MDPE+fee	Not definite
	Agency	Preconstruction services and administering trade contractors	Agent of the Owner but held by CM	-	Owner's risk; C+fee, MDPE+fee	Not definite
AT - RISK CM At-risk CM (CM acting like a general contractor in construction phase)	At-risk CM	Preconstruction services and holding subcontracts	-	Held by the construction manager	No GMP; C+fee, MDPE+fee	Optional fixed contract time
	At-risk CM	Preconstruction services and holding subcontracts	-	Held by the owner but assigned to the construction manager	Optional GMP; C+fee, MDPE+fee	Optional or fixed contract time
	At-risk CM	Preconstruction services and holding subcontracts	-	Held by the construction manager	GMP	Fixed contract time

Key: C+fee – Cost plus fee; MDPE+fee – Multiple direct personnel expenses plus fee; GMP – Guaranteed Maximum Price

Differences are determined in terms of responsibility assignment, services providers, risk distribution and compensation method (Oyegoke 2001c). All forms and variations of CM contracts have the second, third or fourth contractual relationship added to **the root relationship**, agency CM, between a construction manager and an owner (Dorsey 1997, CMAA 1999, Haltenhoff 1999).

Both in agency CM contracting and CM-at-risk contracting, a construction manager is responsible for preconstruction services and the general administration of works such as scheduling meetings, making payments and guarding safety. CM agreements can include **many special clauses** which define in detail how design and construction teams serve each other and an owner (client) as follows.

In agency CM or CM-for-fee contracting, a construction manager assumes the role of a consultant in preconstruction and construction phases as well as administers, co-ordinates and monitors work contractors. An owner holds all contracts with both designers and contractors and bears risks on cost, time and workmanship. A CM consultant's risk is on his professional liabilities and negligence. The clause 1.3.1 of CMAA (1993a) states that "the owner shall enter into a separate contract with one or more contractors for the construction of the project". The article 1.1.2 of AIA (1992a) A201/CMa document states that "there is no contractual relationship of any kind between architect and contractor, construction manager and contractor, architect and construction manager, owner and sub or sub-subcontractor, or between any person or entities other than the owner and the contractor". The clause 2.2 states that "although the owner has direct contractual links with the contractor, he communicates through the construction manager with the contractor". The owner shall contemporaneously provide the architect with such communications (clause 2.2.6). The CM consultant can also provide extended (dual) services, which is termed a design and management option.

In CM-at-risk contracting, a construction manager acts as a consultant in the preconstruction phase and as the equivalent of a general contractor during the construction phase. A construction manager holds all subcontracts and bears risks on time, cost and workmanship quality. A construction manager provides preconstruction services as an agent, holds subcontracts and provides a GMP and a fixed contract period. A construction manager may or may not self-perform some works (Dorsey 1997). In the document A121/CMc/section A2 (AIA 1991), a construction manager assumes also the financial responsibility for the construction works. The article 6.1 in the document No. GMP-3 (CMAA 1998b) states that the construction manager has the right to perform works by his own forces and to award separate contracts or allow utility owners to perform some works. Therefore, his liability is like that of a constructor/contractor concerning project quality, time and cost. According to the article 1.3 of the document No GMP-1 (CMAA 1988a), "the owner will require the construction manager to contract directly with such contractors as may be necessary for the construction or supply of the project". The clauses 1.2 and 1.4 state the relationships of owner and architect, construction manager and other participants, respectively. An owner in a consultation with a construction manager contracts separately with design professionals while the construction manager must endeavour to maintain a working relationship with design professionals. In addition, the dual agent/independent contractor status of a construction manager creates a potential for a conflict of interest during feasibility and design phases. However, such dual services can be eliminated via separate contracts for each service.

3.4.1.2 CM contracting in the UK

Basically, there are **the two types of CM contracting systems** in the UK: the construction management contracts and management contracts (CIRIA 1983, Willis et al. 1994). **In construction management contracting (CMC)**, an owner (client) assumes the contractual position of a main contractor and engages directly works contractors to carry out construction works as subcontractors. The conventional allocation of risks remains unchanged (CIRIA 1983, Seeley 1997). In turn, a construction manager acts as an owner's agent being responsible only for works related to the setting up of a site and the works associated with preliminaries.

In management contracting (MC), an owner appoints first a professional team that prepares project drawings, specifications and bills of quantities which broadly describe the scope of a project. The head of a team is usually an architect. The owner also appoints a management contractor at the early date who is a project planner, manager and organiser. A management contractor provides site supervisory, technical and administrative staff as well as puts in place special facilities to be shared by subcontractors. He plans, co-ordinates, organises, supervises and generally manages and secures construction works (JCT 1987). Ashworth (1991) emphasises that when trade contractors tender the works separately, this leads to the least expensive cost for each trade and, thus, for the construction works as a whole. However, this is an open-ended method since the price can only be firmed up after the final works package quotations have been received. Trade contractors must not without the written consent of a management contractor sub-let any portion of the works (JCT 1998).

3.4.1.3 CM contracting in Finland

In principle, there are **two CM contracting systems** with several hybrids in Finland as defined in Oyegoke (2001), Oyegoke and Kiiras (2001 and 2006) and Kiiras et al. (2002). **In CM consulting** (PJ-palvelu), a construction manager assumes the role of a consultant to an owner and administers the works of first-tier/prime contractors. He does not bear any risk in project costs, time or workmanship quality. An additional site management consultant may or may not provide special facilities that are not common to trade contractors. An owner holds all contracts (Oyegoke and Kiiras 2006). The articles 2.1, 2.2, 3.1 and 3.2 of the Finnish conditions for consulting contracts set out the status and liabilities of both an owner (client) and a consultant. The articles 2.1.3 and 2.1.4 empower an owner with decision-making and supervision during the assignment. The article 3.1.1 states that a consultant is acting in a capacity as an expert. He should perform his assignment in a professional manner in compliance with good technical practice (KSE 1995). The article 3.2.2 states that a consultant is liable for damages caused to an owner due to his error or negligence (KSE 1995).

In CM contracting (PJ-urakointi), a construction manager as a CM contractor assumes the role of a consultant in development and design phases and the role of a project and site manager in a construction phase, enters into contracts with subcontractors, coordinates and administers the work of subcontractors, provides site services, bears risks on time, cost and workmanship quality and participates in construction activities with his own construction capacity (Oyegoke and Kiiras 2006b). The clause 1.1 of the YSE (1998) sets out a CM contractor’s principal obligation to carry out all works as stipulated in contract documents. The clause 1.2 states further that the contract includes all works required to achieve the agreed finished result. The articles 7 and 8 of YSE (1998) set out the mode of cooperation and collaboration between contract stakeholders, respectively. A CM contractor ensures the smooth and safe execution of works by providing information, reaching agreements and engaging in other forms of cooperation with an owner and other contractors. The article 3 of YSE (1998) supports the optional nature of site services.

3.4.1.4 Comparison of CM contracting systems in the USA, the UK and Finland

In the USA, the UK and Finland, **CM consulting** includes the national forms of agency CM, construction management contracting (CMC) and CM consulting, respectively. In turn, **CM contracting** includes the national forms of CM-at-risk, management contracting (MC) and CM contracting, respectively (Oyegoke 2001c) (Figure 6).

This 2-form classification seems to be **consistent** with all three national constructing systems. Frequently, same basic similarities and differences are to be found around seven key theoretical themes, i.e. definitions, contractual links and arrangements, information links, contractual risks, project responsibilities, the roles of CM firms and the types of organizations that are engaged in CM tasks in product development and construction phases (Oyegoke and Kiiras 2001).

3.4.2 Responsibility distributions in the USA and the UK

CM contractual processes are determined by owners in terms of CM contract forms and their variations within each national CM contracting system.

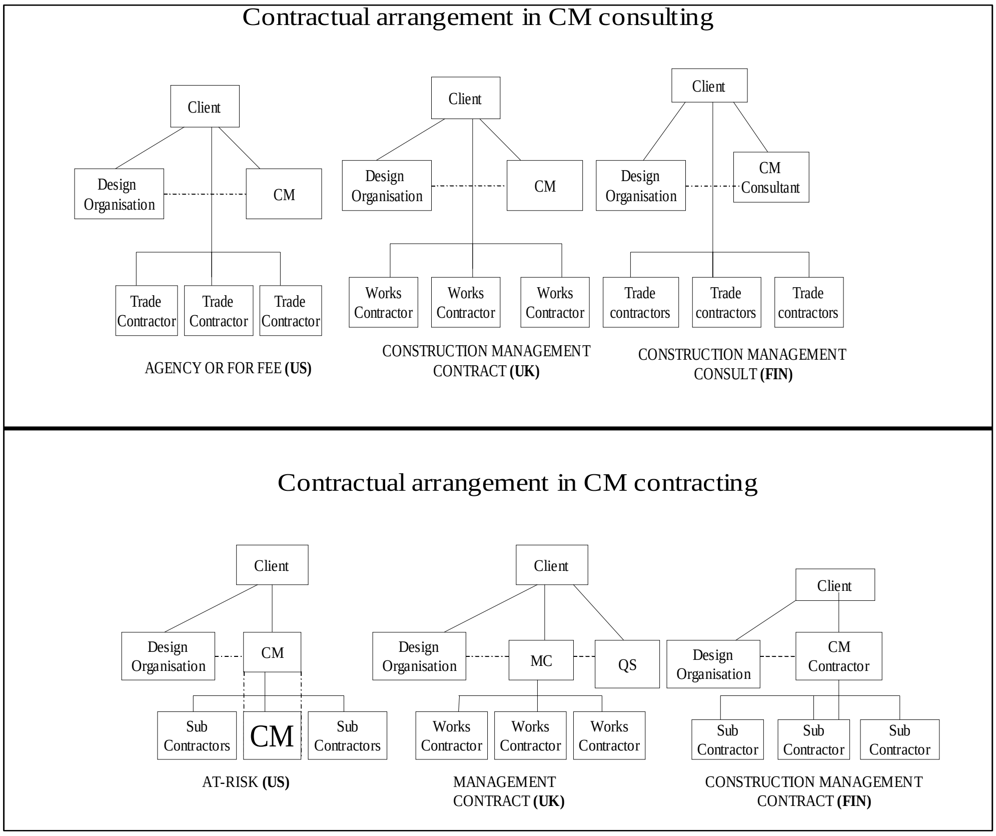


Figure 6. Comparison of CM consulting and CM contracting perspectives in the USA, the UK and Finland.

In the USA, the article 2.1 of CMAA (1993b) Document No. A-3 (1993b) states that the construction manager shall administer the contract and act as the owner's principal agent in all matters. **The responsibilities of the construction manager in preconstruction phases** are governed as follows. The owner hires the CM firm about at the same time with the A/E. This is to allow exposure and compatibility checks. The articles 1, 2 and 3 of AIA (1992b) B141/CMa highlight the architect's responsibilities and basic and additional services. In turn, CMAA (1993c) Document No. A-4 highlights the relationship of the project parties concerning design, etc. In AIA (1991) A121/CMc-AGC Document 565 and AIA (1992c) Document B801/Cma, the construction manager shall review design documents during their development and advise on the proposed site use and improvements, the selection of materials, the building systems and equipment and the project delivery method. The construction manager should also provide recommendations on the relative feasibility of construction methods, the availability of materials and labour, the time requirements for procurement, the installation, the construction and the factors related to construction costs including, but not limited to, the costs of alternative designs or materials, preliminary budgets and possible economies.

CMAA (1993c) Document No. A-4 includes the standard form of **the agreement between the owner and the professional design team**. It highlights the relationship of the project parties with regard to design, basic services to be provided by design professionals in all project phases, additional services, the owner's responsibilities and the compensation and payments for design professionals' services. The article 4.15.1 of CMAA (1988b) Document attests to the fact that the contractor should forward all communications to the construction manager. Article 3.1.1 enjoys the contractor to provide safe facilities for the owner's access.

In turn, the construction manager advises on **the division of the project into individual works contracts** for various categories of work including the method to be used for selecting contractors and awarding contracts. The construction phases commence with the awards of the initial construction contracts or purchase orders. The construction manager provides administrative, management and related services to co-ordinate scheduled activities and the responsibilities of the contractors with each other and with those of the construction manager, the owner and the architect. It is stated in the article 4 of AIA (1992a) Document A201/CMa that the construction manager administers the works contracts in co-operation with the architect (AIA 1992a-c). For instance, the article 3.2.5 of CMAA (1993c) Document No. A-4 states that the construction manager and the design professionals shall maintain a close liaison and have the frequent interchange of information and documentation to achieve compliance with the project and the construction budget. The construction manager furnishes to the owner and the architect a list of the subcontractors, including the suppliers of materials and equipment. The architect must promptly reply in writing to the construction manager if the owner or the architect has any objection to such subcontractors or suppliers. The construction manager must recommend to the owner and the architect a schedule for procurement of long-lead time items that constitute part of the work required for meeting the project schedule.

In CM-at-risk contracting in the USA, the overall project risk of price, quality, performance and contract duration is placed on the construction manager who may offer the option **with the GMP** and the fixed contract period. The construction phase commences when the owner accepts the GMP proposal and issues a notice to the construction manager to proceed. In turn, AIA (1994) Document A131/CMc lists the construction manager's responsibility in a project where the construction manager is also the constructor **without the GMP**. The preconstruction and construction phases may proceed concurrently.

In the UK, **the relationships between a management contractor (MC) and designers** must be established to enable the change from design office to site to be smooth and efficient. As the project is split into many work packages, the MC directly contracts with works contractors and nominated suppliers for the successful execution of the project (JCT 1987). The clause 1.7.1 of Works Contract/2 states that each works contractor is responsible for carrying out and complete the works in compliance with the works contract. The clause 1.5.4 states that the MC must 'provide or secure the provision of such site facilities and services as are listed in the Fifth schedule or ----- as may be agreed with, or may be instructed by, the architect. Appendix C of MC/1 (JCT 1987) practice note sets out a model checklist for the site services and facilities to be provided by the MC. Therefore, the provision of special site services is mandatory (while it is optional in the CM contract, but it is usually provided by the construction manager).

3.4.3 Risk allocations

In general, **risk managemen**t can be perceived from different perspectives. Hertz and Thomas (1983) have identified the identification, measurement, evaluation and re-evaluation as the phases of risk determination processes. Chapman and Ward (1997) have outlined a risk management process (RMP) for various projects. In turn, **PMI (1996)** categorises risks into internal risks (within the control) and external risks (beyond the control). PMI (2000) defines project risk as an uncertain event or condition that has a positive or negative effect on project objectives. Project risk management is a systematic process of identifying, analysing and responding to project risk. This can be achieved by maximising the probability and consequences of positive events and minimising the probability and consequences of adverse events to project objectives. **In the CM context**, Lifson and Shaifer (1982) have asserted that decision and risk analysis provides a construction manager with concepts, language and an organising framework for dealing with complexities, non-linear factors, uncertainties, dynamics and value systems inherently present in CM decision problems. Typically, construction projects are complex processes that involve many stakeholders, long project durations and complex contractual relationships. All these factors increase the likelihood of project risks.

Herein, **the review of the risk allocations as part of the national CM contracting systems** is restricted to the ones in the USA and the UK in terms of three contract documents, i.e. the CMAA standard forms of agreement NO A-1 and GMP-1, the JCT standard form of management contract and CM services and practice document. The risk-related clauses of the standard forms are arranged by the phases that are defined in PMI's (2000) project risk management process: management planning, identification, qualitative analysis, quantitative analysis, response planning, monitoring and control. Finally, the comparative remarks are based on similarities and differences in managing risks as part of two national contracting systems.

3.4.3.1 Risks analysis based on the CMAA forms of agreements in the USA

In the US context, **risk management practice** is elaborated well by Haltenhoff (1999) as follows. There are twelve areas in the CM body of knowledge such as project, budget, contract, decision, information, material/equipment, quality, resource, risk, safety, schedule and value management. Some areas are highly specific and technical (e.g. scheduling and value management). Others tend to be obscure and more general (e.g. decision management). In every construction project, **the primary risk categories** include cost and time over-runs, quality deficiencies and business interruptions that result from project-related disputes. Dynamic risks are speculative with a gain/loss potential without definitive solutions. Static risks involve fortuitous chances for loss without an opportunity for gain), i.e. they are pure risks that have definitive solutions. In practice, it is impossible to separate dynamic risks and static risks, because determining static-risk action depends on a dynamic-risk decision. The ways of managing static risks includes elimination, avoidance, prevention, reduction, assignment, expensing or retention, surety bonding and insurance. The management of dynamic risks needs to be incorporated in contracting, design and construction processes and procedures.

In the CMAA (1999) documents, the basic functions, i.e. cost, time, quality, project/contract and safety management are addressed as the integral components of the CM process. Hence, each function is divided into phases of pre-design, design, procurement, construction and post construction. Herein, risk management is analysed only in **three exemplary areas**, i.e. cost management, time management and project management based on the CMAA standard forms of agreements No. A-1 and GMP-1 as follows with overall detailed analysis in Appendices 2, 3and 4. Tables 4-7 and Appendices 3-5 were derived via the extraction of the information from the source documents in line with PMI's principles of project risk management.

In Table 4, **the cost management areas** are presented by phases. A construction manager carries out a construction market survey in order to arrive at the approximate project and construction budgets. Quantitative methods to be used include cost analysis, life cycle costing, energy studies, etc. This allows a construction manager to review budgets with design professionals and an owner. In order to enhance opportunities and to reduce threats, a construction manager develops various design and construction alternatives. He controls risks by monitoring and reviewing project and construction budgets as well as he prepares trade-off studies on materials and systems and assesses the effects of change orders (Appendix 2).

Table 4. Management of project cost risk based on the CMAA standard form of agreement (No. A-1)

Theme	**Project phases**	**Planning**	**Assessment**			**Management**	
		Management planning	**Identification**	**Analysis**		**Response planning**	**Monitoring & control**
				Qualitative	**Quantitative**		
Cost mana-gement	Pre-design 3.2.3	Construction market survey	Project and construction budget(s)	Budgets with design professional and owner	Cost analysis, usable life, energy studies, etc.	Various design and construction alternatives	Project and construction budgets
	Design 3.3.3	Estimate of construction cost	Project estimates	Revision of project and construction budget	Value analysis studies	Revision and recommendations on project and construction budget	Cost control and monitoring
	Procure-ment/Bid and award 3.4.3	Estimate of addenda	Bid analysis and negotiation	Evaluation of alternat-ive bids and unit prices	Cost analysis, usable life, energy studies, etc.	Construction contract recommendations	Estimate of cost for addenda
	Construction 3.5.3	Trade-off studies on materials, systems, etc.	Project costs overruns	Effect of change orders on cost	Allocation of cost to contractor's construction schedule	Contract price allocations	Cost records and progress payments
	Post-construction 3.6.3	Effect of change orders on the project	Total project cost	Unresolved change orders	All change orders	Unresolved change orders with cost impact	Project costs and the final cost report

In Table 5, **the time management areas** are presented by phases. In construction phases, the risk awareness of a construction manager is focused on managing construction schedules. He starts by reviewing contractors' construction schedules, by looking for methods to recover lost time and by analysing time extension requests prior to the issuance of change orders. Response planning takes place in a form of reviewing the progress of the construction works of each contractor on a monthly basis. In order to monitor and control the project schedule, the construction manager evaluates the percentage complete of each construction activity in respect to each contractor's construction schedule (see also Appendix 3).

Table 5. Management of project time risk based on the CMAA standard form of agreement (No. GMP-1)

Theme	**Project phases**	**Planning**	**Assessment**			**Management**	
		Management planning	**Identification**	**Analysis**		**Response planning**	**Monitoring & control**
				Qualitative	**Quantitative**		
Time mana-gement	Pre-design 3.2.2	Master schedule	Time overruns	Master schedule	Design/project schedules	Design phase milestone schedule	CM plan updates
	Design 3.3.2	Pre-bid construction schedule	Realistic design phase schedule	Revisions to the master schedule	Milestone/ pre-bid con-struction schedule	Pre-bid construction schedule	Milestone and pre-bid construction schedules
	Procure-ment/Bid and award 3.4.2	Pre-bid construction schedule	Contractor's construction schedule	Contractor's schedule responsibilities	Revision of the milestone schedule	Revisions of master schedule to bidders	Contractor's construction schedule
	Construct-ion 3.5.2	Contractor's construction schedule	Construction schedule	Recovery schedules	Effect of change orders on schedule	Periodic construction schedule report	Schedule compliance and construction progress
	Post-construction 3.6.2	Occupancy plan	Occupancy plan	Location schedule for materials	Location schedule/move-in frequency	Owner's ratification of location schedule	Occupancy plan

For example, **risk response development** aims at finding both opportunities and responses to threats. Control uses insurances, indemnities and bonding (performance, payment and professional indemnity bonds). The clause 9.1 and the clause 8.1 of A-1 and GMP-1, respectively, address the liability insurance. A construction manager must have an insurance to prevent him from claims under workers' compensation, disability benefits, bodily injury, disease or death, or the third party, etc.

Likewise, an owner must purchase and maintain its own liability or additional insurance for further protection. Both owner and construction manager indemnify and hold harmless each other against any claim, demands and suits for which any of them is liable. In addition, there is a waiver of subrogation between an owner and a construction manager against contractors, design professionals, consultants, agents and the employees of the other, and between an owner and a construction manager from contractors for damages during the construction covered by any property insurance as in the conditions of contract.

In Table 6, **the areas of project management** are compiled by phases. In the pre-design stage, a project owner assembles and organises a project team/organisation (a construction manager and designers) and provides the project purposes to the team. The construction manager then quantifies this process by outlining the CM plan (CMP) as a strategy for fulfilling the owner's requirements. The construction manager plans, conducts and documents the pre-design conference which addresses the CMP with respect to the design phase and establishes the management information system (MIS) to keep the team informed as to the overall status of the project. The project team writes out the project procedure manual (PPM) that outlines the responsibilities of the team, the levels of authority, systems, methods and procedures to be followed for the project execution. CMP and PPM serve as the control techniques (see Appendix 4).

Table 6. Management of project risk based on the CMAA services and practice

Theme	**Project phases**	**Planning**	**Assessment**			**Management**	
		Management planning	**Identification**	**Analysis**		**Response planning**	**Monitoring & control**
				Qualitative	**Quantitative**		
Project management	Pre-design	Project team with the owner	Project organisation & project requirements	Relation-ships btw. the stake-holders	Team members' responsibil-ities	MIS	CMP and PPM
	Design	Pre-design project conference	Design documents and project funding	Design document review	Contract agreement review	Periodic project meetings	Cost and time control
	Procurement	Ongoing consulting activities	Bidding and contracting process	Provision for permits, insurance and labour affidavits	Bid opening and evaluation	Pre-bid meetings, bid opening and pre-award conferences	Compliance with construction contracts execution
	Construction	Professional planning and project execution	Construction process efficiency	Verification of on and off site facilities	Cost, time and quality compliance with plan	On-site meeting and management reporting	Claims, time and quality management, and manage-ment reporting
	Post-construction	Effective project documents transmission	Effective project close-out	Verification of docum-ents related to move-in or start-up	Manuals and record drawings	Final documents e.g. final cost report	Post-construction project/contract administration

3.4.3.2 Risk analysis based on the form of the management contracts in the UK

In the UK context, **risk management practice** has been guided in the early 1980s as follows. For the success of any construction contract, risks must be acknowledged and allocated between project parties. Each risk should by carried by the party who is best capable of assessing, evaluating and controlling it. There must be awareness for incentives in allocating risks. For ensuring that all parties perform efficiently, such incentives include bonds, insurances, retentions, bonuses and incentives, liquidated damages, defect and maintenance periods, warranties, etc. (CIRIA 1983). In addition, the primary burden of risks on construction projects falls between a contractor and an owner (client). Insurers often carry low probability, high impact risks such as a fire or a collapse. Fundamental risks are liabilities and responsibilities that are inherent in projects between parties. The standard forms of building contracts allocate risks between parties according to the well-known basic terms. Therefore, risk allocation in projects takes place in a form of assigning responsibilities and setting out liabilities. Consultants can only accept the risk for their professional integrity and competence. Low productivity on sites is a controllable and acceptable risk for general contractors to manage. The greater the risk the party must carry, the greater the reward that this party is searching for (Flanagan and Norman 1993). In the Latham (1994) report, risks were recognised, too: no construction project is risk-free. Risk may be managed, minimised, shared, transferred or accepted – but not ignored.

In CM contracting, a construction manager manages the process and acts only as an owner’s agent. Therefore, the client has a considerable exposure to the burden of risk and reward potential (Cox and Thompson 1998). **In management contracting**, a management contractor manages the project as a whole, design and construction, administers all contracts as well as supervises and co-ordinates works on site. He prepares all programmes, cooperates with the professional team, enters into work contracts and ensures that work contractors carry out all items. He secures the provision of site facilities and services and provides the continual supervision of the project (JCT 1998).

Herein, the section 1 of the JCT (1998) standard form of management contract is used for the analysis of project risk management as follows. In Table 7, **the areas of project risk management** are compiled by phases. In the procurement phase, a management contractor prepares tender documents and obtains tenders from works contractors/suppliers. He advises on the breakdown of the project into packages for works contracts, prepares the lists of potential work contractors for tendering and investigates their capability, capacity and financial standing. For the response planning and control, a management contractor prepares a list of potential works contractors and prepares work contracts placements with an architect as the control and monitoring tools. According to the clause 6.6 of JCT (1998), a management contractor must take out and maintain the insurance for the loss of liquidated damages until the practical date of completion on an agreed value basis to avoid dispute over the amount due under the insurance. The owner (employer) and the management contractor must indemnify each other concerning the consequences of a breach of the Joint Fire Code (the clause 6FC.4). They must also take out and maintain the Joint Names Policy when taking risk related insurances for the full reinstatement value of the project. The conditions of contracts also enjoy a management contractor and works contractors to indemnify an owner concerning claims arising out of their liabilities against injury to person and property when carrying out the project (the clauses 6.7-6.10).

Construction works often involve project risks that result in **submitting claims** for the extensions of time or financial entitlements for an actual loss and a loss on profit. Claims are complicated and difficult. As a rule, professional judgement is needed to scrutinise what constitutes a claim. Seeley (1997) defines a claim as a request by a contractor to recompense for some loss or expense that he has suffered or an attempt to avoid the requirement to pay the liquidated and ascertained damages.

Table 7. Management of project risk based on the JCT Management Contract (1998)

Themes	**Project phases**	**Planning**	**Assessment**			**Management**	
		Management planning	**Identification**	**Analysis**		**Response planning**	**Monitoring & control**
				Qualitative	**Quantitative**		
Intention of the parties	Pre-design	Cooperation with the professional team	MC project obligations	Planning supervision	Checking of compliances with the instructions	Preparation of programme	Securing of compliance with the instructions
	Design	Advice on contract document	Contract documents	Architect's explana-tion and documents amplifica-tion	Review of contract documents with the professional team and the owner	Advice on practical implications	Inspection by the MC
	Procur-ement	Assistance in preparation of tender documents	Tender documents	Advice on suitable work pages for works contractors	Investigation of WC's capability, capacity and financial standings	Preparation of lists of potential WC	Preparation of work contracts placement with the architect
	Con-struct-ion	Cooperation with the professional team	Supervision of construction work	Setting and securing of the site	Adherence to and compliance with architect instruction and fifth schedule	Advice on the build-ability	Control of the project
	Post-con-struct-ion	Assistance in preparation of a certificate of practical completion	Practical completion	Securing of the rectifi-cation of defects	Conclusive evidence that quality standards are met	Advice on the issue of certificates	Conclusive evidence for the final certificate

Bubshait et al. (1998) explain that during construction projects, delays may be caused by owners, contractors, by acts of God and the third parties. **The actions of an owner and his representative** that cause additional costs to contractors in executing the project constitute genuine claims. Claims result from the prolonged presence on site, additional overhead costs, profit losses due to extended periods, site and general overheads, the extended attendance of the nominated subcontractors, extra winter costs, extra costs on preliminaries, variations and acceleration costs.

In turn, **the delays of contractors** which cause the non-completion at the predetermined completion times result in payments for liquidated damages. Contractors should compensate for the losses of benefits from the inability of owners to make use of projects at the agreed completion dates. Claims that result from **an act of God** are stated in the clauses 25.4.1-3 of JCT 80 Standard Form of Building Contract under relevant events, i.e. force majeure, exceptional (unpredictable) weather conditions, losses or damages occasioned by specified perils e.g. an earthquake or a flood. In such situations, the extensions of time are given to contractors. Claims that arise due to **third parties** are stated in the clauses 25.4.4-16 of JCT 80. They include civil commotions, the local combinations of workmen, strikes or lock-outs, delays on the part of the nominated subcontractors or suppliers, delays in giving instructions to contractor, etc.

3.4.3.3 Comparison of the risk analyses of the national CM contracting systems

The comparison of the risk and responsibility distribution in the CM contracting systems in the USA and the UK appears in Appendix 5. Herein, it can be synthesised that an owner bears risks in CM consulting forms while risk lies with a CM contractor in CM contracting forms. The previous analyses of the risk management under CM contracts via PMI's principles reveal that the standard forms of CM contracts as well as CM services and practices readily encompass risk awareness and risk management in terms of identifying, quantifying and developing the ways of responding and controlling project risks**.** Risk management procedures consist of three essential phases: planning, assessment and management.

In Figure 7, **the 3-part scope of risk management** in the three national CM practices is synthesized. The inner core consists of 3 countries x 2 two CM perspectives, i.e. project responsibilities are allocated among the CM consulting and the CM contracting perspectives in the US, UK and Finnish contexts. The middle area shows a construction manager's responsibilities and risks. The outer boundaries show parties that carry key responsibilities and/or risks. In CM consulting (agency CM of the USA, CMC of the UK and CM consulting of Finland), risks on prices and contract durations lie with owners. In CM contracting (CM-at-risk of the USA, MC of the UK and CM contractor of Finland), risks on prices, quality and contract durations are placed on construction managers who act like general contractors in construction phases.

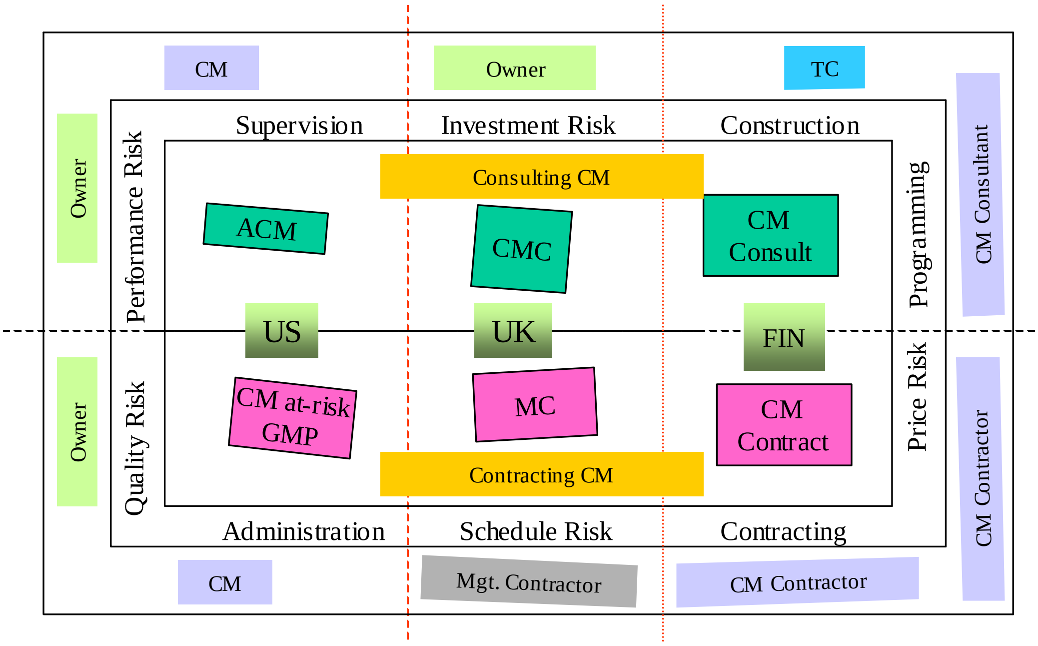


Figure 7. Risk analysis in CM contracts

In Figure 8, **project resources management** is illustrated in terms of assigning responsibilities to project parties. Each risk occurs related to responsibilities. A failure or a default of one party to carry out his responsibilities results in a liability financially (a direct or consequential loss), a recovery of the schedule or an extension of time, etc. It may result in a penalty via claims (liquidated and ascertained damages), an additional responsibility, a contract termination or a suspension. Remedies include insurances (injuries to third parties), indemnities, waivers and subrogation and dispute resolutions.

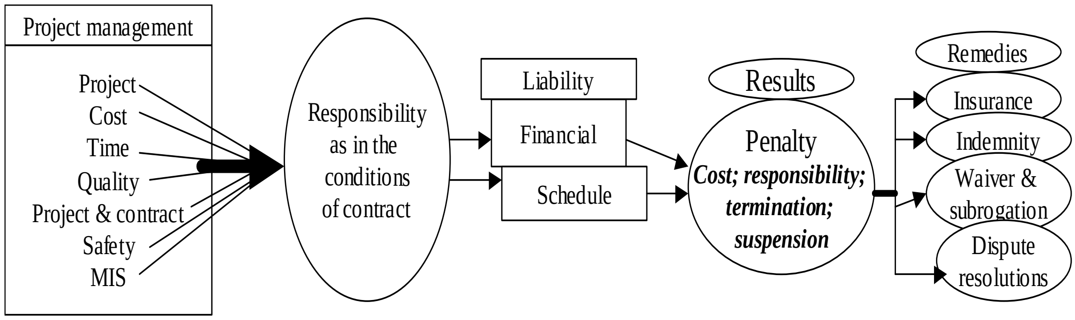


Figure 8. Classification and effects of project risks in relation to resources management

For example, the CMAA standard forms of agreements state that the construction manager as an agent shall be named as an additional insured in the owner's and the contractor's insurance policy (clauses 9.2.2 and 8.4). In the clause of 6.3. of JCT's (1998) MC conditions, the MC and the owner (employer) insure each works contractor, e.g. they include the waivers by the insurers of any right of subrogation against such works contractors.

3.4.4 Compensations, payments, contingencies and guaranteed prices

3.4.4.1 Compensations and payments

In all CM contracting forms, target budgets are calculated for an owner with possibilities for an extra earning or a bonus or a sanction. In bonus models, the bonuses are paid after all the objectives have been attained in terms of the target quality, the costs, the schedule and the co-operation. Compensation and payment procedures differ between CM consulting and CM contracting perspectives as follows.

In CM-for-fee contracting in the USA, a construction manager is paid a fee that is linked to the project cost or the amount of time or the resources employed (e.g. for supervision). Extra earnings/bonuses or sanctions are possible. Dorsey (1997) emphasises that fee arrangements are usually based on one of three models: fixed fee plus reimbursable, percentage fee of cost of the work plus reimbursable or multiple of direct personnel costs plus reimbursable. Haltenhoff (1999) categorises CM fee structures to include lump sum, cost plus, a combination of both and an incentives and merit fee structure. Some peculiar fee structures include a lump sum with or without an added cost clause, a lump sum plus reimbursable, reimbursable or fee enhancement provisions either as an incentive arrangement or a performance reward. In CMAA (1993), a construction manager receives compensation as a lump sum fee or a cost plus fixed fee for basic services and direct expenses (Figure 9).

In CM-at-risk contracting in the USA, the fee of a construction manager is linked to the project costs. Haltenhoff (1999) categorises a fee structure to include a lump sum, with or without a contingency clause, a lump sum plus reimbursable, fee enhancement provisions and a financial risk enhancement. According to the articles 4 and 5 of AIA (1991) and the article 3.5.3 of CMAA (1988a), stipulated sums, multiple direct personnel expenses and actual costs are used **in preconstruction phases**. In turn, owners compensate construction managers' actual costs incurred in relation to labour

Compensation for CM services & payment Cost plus fixed fee	
• BASIC SERVICES ▪ fixed fee + ▪ cost of the employee working on the project (excluding principal) + ▪ personal expenses for each employee (taxes, payroll, benefits, insurance) + ▪ cost of employee assigned to the project & work on site (excluding project manager & assistant) + ▪ cost of employee assigned to the project & work in CM's office (including project manager & assistant) + ▪ principal of CM who participate in the project; rate per hour ▪ consultants employed by CM for the project	• DIRECT EXPENSES (actual expenditure) ON BASIC & ADDITIONAL SERVICES ▪ long distance telephone calls/telecommunication ▪ handling, shiping & reproduction of documents ▪ transportation and living expenses, computer soft, hard wares and processing ▪ insurance premium ▪ relocation of employees and their families ▪ gross receipt taxes, sales taxes etc. ▪ field office expenditure ▪ costt of premium time ▪ legal cost

Figure 9. Compensation and payments for CM services

costs, subcontract costs, the costs of materials and equipment incorporated in the completed construction and the costs of other materials and equipment, temporary facilities, miscellaneous costs (insurances and bonds), emergencies and repairs to damages or nonconforming works **in construction phases**.

In management contracting in the UK, CIRIA (1991) categorises payments into (i) fee elements that cover management services plus an additional lump sum for site services and facilities depending on the project's value and nature, the extent of services and risks and (ii) cost reimbursable elements that include works contractor payments, direct costs and associated overheads of all on-site personnel, costs incurred by head office staff when visiting the site and the costs of specified common user and site facilities. When a management contractor holds the finances, a merit usually involves payments as monthly instalments to control better works contractors. When the practical completion has been achieved, an architect is required to issue a certificate. During the defect liability period, a management contractor must secure the rectification of defects. Similarly, each works contractor carries out the rectification of defects not only after the completion of his own work but also during the management contract defects liability period (JCT 1987).

3.4.4.2 Contingencies and guaranteed maximum prices

In the USA, contingencies are found in all types of CM contracts. Dorsey (1997) classifies contingency sums according to the controller: construction manager and owner. **In agency CM**, contingencies are largely used for budget purposes. Haltenhoff (1999) defines contingencies as budgeted money exclusively dedicated to compensate for unforeseeable costs, which can be classified into (i) a contingency that covers indeterminate construction market costs and estimation infirmities and (ii) a contingency that covers unpredicted project conditions and circumstances (individual line item contingencies include design, work-scope interfaces, cost escalation and scope changes).

In CM-at-risk contracting with GMP, where design documents are incomplete, contingencies are essential to address the usual cost growth that occurs during the further development of drawings and specifications. Contingency also covers the construction stage cost growth, which is properly reimbursable as the cost of the work but not as the basis for change orders (Dorsey 1997). The maximum price includes the actual cost of the work, a construction manager's fee and contingencies. In principle, owners do not reimburse construction managers for exceeding guaranteed prices. The scope of works must be defined because scope variations affect the GMP. Changes in the scope of work such as increases in project size or the distinct revisions of some of systems as well as additive change orders amount to revised GMPs (Dorsey 1997). AIA (1991) and CMAA (1988a) outline conditions and steps in arriving at the GMP and contract time. Within the target price mechanism, a target price is set and the savings between the GMP and the target price are shared between a CM-at-risk contractor and an owner (Figure 10). In GMP-based contracts, the compensation and the allocation of the contract price are based on the schedule of values for each of the construction contracts (CMAA 1998a).

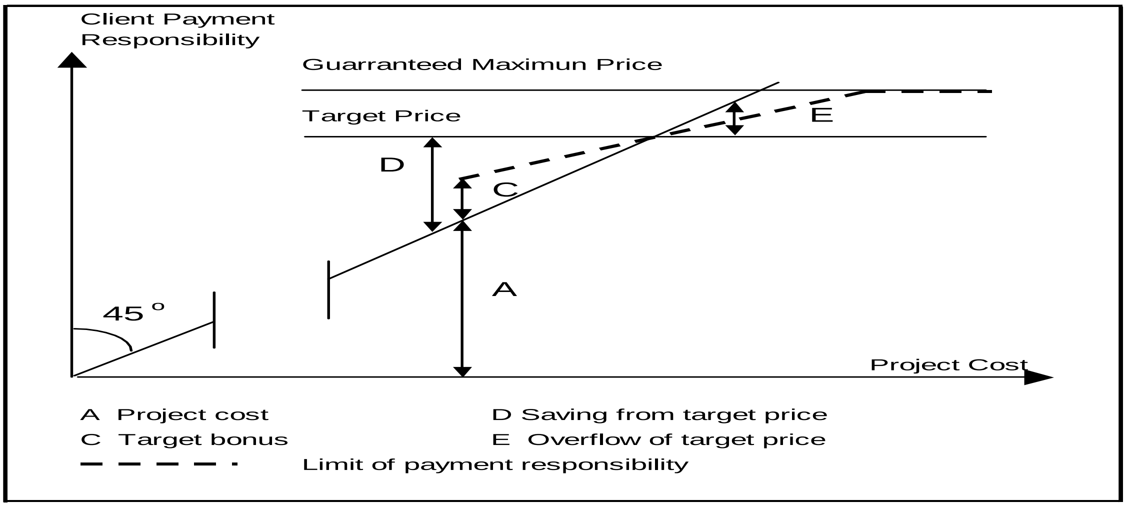


Figure 10. Target price determination in the CM approach.

3.5 Discussion on Current Procurement Practices

In this chapter, the current procurement routes and their variations have been comprehensively analysed in order to determine their elements and operational modes. Herein, the status of the procurement routes and the existence of many inherent problems are discussed in order to justify the design of a new STO route.

Within the current classifications of procurement routes, there are two extreme edges: **the fragmentation and integration of contracting processes**. The in-depth analysis reveals that the most important issue is the allocation of points of performance responsibility. Typically, D-B contractor or general contractor-centred routes result in the prevention of direct specialist organisation involvement, which subsequently hinders innovations, specialisation and competitiveness development. The differences between the basic contracting systems are to be located in terms of contractual ties, the assignment of responsibilities of parties, the levels of subcontracts and legal performance requirements. A weakness of one route is the strength of the other one making the current routes ineffective functionally and operationally. Therefore, there is a need to combine their strengths and eliminate their weaknesses for better organisation set-ups. The prevalent procurement routes have not solved the problem of owner dissatisfaction in construction because the levels of the claims, the changes and the additional work during the project implementation processes have been increasing (as discussed also in Chapter 1).

In turn, the analysis of general risk management and control in CM contracting via PMI's risk management principles shows that risks are well-covered. But **the allocation of these project risks and responsibilities** tends to follow the main party that holds the contract without searching for a truly better alternative where the party, who is best suited or actually carries out the specific work, also bears the risk of his work. Similarly, well-defined compensation methods have been developed where maximum prices are guaranteed and bonuses are paid depending on the savings. The late involvement of the CM consultant and the dual conflict of the interests between the CM contractor and the owner, respectively, prompt a need for the real improvement of price certainty during preconstruction phases.

Despite a large number of management oriented works on the re-engineering of contracting processes (as discussed in Chapter 1), there is still a need for better value adding mechanism in terms of short feedback loops, the proper definitions of owners' requirements at inception phases and the actual re-engineering of contracting processes.

Overall, **a new approach** is needed in order to decrease underlying uncertainty and to enable the full attainment of owners' project objectives. Such new solutions should properly allocate risks and responsibilities, encourage the use of life cycle costing and take into consideration the effect of maintainability from the beginning of preconstruction phases. It seems that one viable solution can be based on the higher involvement of specialist organisations throughout project design and construction phases. Hence, the new STO route is designed next in Chapter 4.

4 SPECIALIST TASK ORGANISATION (STO) ROUTE

Herein, the new concept of the Specialist Task Organisation (STO) route is designed in terms of its basic definition and positioning along project delivery and financing dimensions, an operational model, contractual arrangements, communication, coordination and co-operation systems, risk allocation, responsibility distribution and compensation methods, value adding chains and some constraints. The operational mode of the suggested STO route is developed in terms of the key variables inherent in procurement processes and procedures.

4.1 Concept of the STO Route

By the mid-2000s, it seems that the primary problem of **high client dissatisfaction in construction** caused by severe defects inherent in procurement and supply chain management remains unsolved in the US, UK and Finnish contracting systems despite the fact that several new procurement routes (e.g. D-B) have been developed and adopted to improve contractual and implementation processes. There are many factors that are directly associated with client dissatisfaction such as non-completion on time, excess costs, poor quality and low performance. It is herein argued that most project delivery systems, contracting systems and procurement routes are **either completely fragmented or integrated with associated management systems**. The latter may be effective in repetitive projects, partnering, incentive based and financing driven approaches (e.g. PFI and PPP in public projects). **The insufficiencies in the current procurement routes** are herein characterised as follows: (i) procurement routes are based on the extensive fragmentation of the total process (the multiple points of responsibility) or (ii) procurement routes are based on the complete integration of the total design and implementation process (a single point of responsibility). The shortcomings due to this 2-extreme edge classification take on the disadvantages of fragmentation for the advantages of integration and vice versa, leaving the total project and procurement management problem unsolved.

The high client dissatisfaction triggered this author to revisit **the original management approaches** in order to find some new ways of developing better procurement systems or routes. The work of Adam Smith of 1776 is regarded as the ultimate source of productivity and quality improvement through the division of labour (value production). Specialisation emerged with the fundamental question of co-ordination of specialists for success. Nowadays, co-ordination principles are applied to both traditional production lines within the boundaries of single organisations and to managing fragmented supply chains with many organisations. Heikkilä (2000) emphasises that supply chain management is aimed at managing and co-ordinating a supply chain from raw material suppliers to ultimate customers. Readily, many manufacturing companies have recorded the major achievements in the (mass-) customised production of products with unique features by using tens of suppliers from several countries across the globe, enabled by advanced (semi-)automation and ICT systems. An onerous task of supply chain management is to co-ordinate inter and intra-company activities as specialisation is exploited among multiple independent specialised suppliers.

In turn, it is herein envisioned that construction projects with their procurement and implementation processes be managed better through **the combinations of new**

solutions for the management of project development, building design and construction production (value chain). New combinations may readily exploit the existing principles guiding both integration (e.g. D-B contracting) and fragmentation (e.g. agency CM). New combined solutions contradict the work of proponents of exploiting either extensive fragmentation or full integration. Combinations can be innovative and fragmented/differentiated under the integrated management system. They align all project parties with the common goal of producing economic, on-time and high-quality construction projects. Internal decision makers and other key actors who influence decision making processes within clients' organisations can be replaced or complemented by various external specialists who, in turn, act on behalf of clients on a contractual basis. Alternatively, a contractor or a consultant may become engaged with dual responsibilities of contracting, procurement, design and construction.

This dissertation proposes **a new concept of a specialist task organisation (STO) route** for improving the current contracting systems, procurement routes and processes in construction projects. Under the robust integrated management (system), the STO route applies the principles of specialisation and innovation to carrying out the core tasks/activities through project development, building design, construction and possibly maintenance. The STO route utilises semi-autonomous integration in project development/building design processes and full fragmentation in construction processes. The total scope of the project/building in question is procured from among organisations that are specialised in the various development, design, manufacturing, supply, installation, construction and maintenance tasks.

Along this route, an owner forms for his project **an STO management team** which, in turn, procures the total project/building development plan with design documents from among specialist designers. An STO management team comprises of designers who act under the leadership and management of a project manager. Further, an STO team procures work packages with detailed technical engineering and design documents from among specialist contractors and suppliers. Finally, the life-cycle costing, usability, alternative materials and maintenance services form a part of competitive criteria for the tender evaluation. Each of STOs enters into an agreement with an owner (client). The early selection of specialty contractors to act as team members allows them to provide the owner with their best services. This helps in having the most economic design and system, cost control and in increasing the predictability of significant events and their impacts on cost, schedule and quality (Dorsey 2004).

The targeted advantages of the proposed STO route are as follows: (1) it allows competition among many alternative designs of STOs, (2) it shifts competition to design, life cycle management, materials and maintenance solutions, (3) it exploits expert knowledge in shaping construction processes project by project, (4) it adds more value to project implementation processes due to short feedback loops and clearly defined users' requirements, (5) it prefers specialisation over generalisation, (6) it eliminates paradoxically the weaknesses of the fully fragmented approaches and the fully integrated ways by utilising the biggest merits of both of them, and (7) it enhances construction productivity and eliminates the waste of construction resources by integrating the demand chain and the supply chain. The STO route is more applicable to building projects where prefabricated elements and standardised materials are used as well as to large and complicated building (and infrastructure) projects.

The STO route enhances the development of better communication, coordination, co-operation and information systems. It re-engineers the current ways of arranging contractual relationships, distributing responsibilities, allocating risks and compensating for services. It is adding more value to building construction projects.

4.2 Positioning of the STO Route among Delivery and Financing Methods

In general, project delivery methods (procurement routes) can be positioned along the fragmentation/integration spectrum as follows. **Extensive fragmentation** signifies that there are the multiple points of (performance) responsibility among parties along a project delivery chain. A process is linear, i.e. a situation where each party performs its duties and then passes relevant information and responsibilities to the next party. There are the boundaries of responsibilities between designers, contractors, nominated subcontractors and suppliers that prevent from integrating special knowledge and solutions possessed by parties.

Conversely, **full integration** means that there is a single point of (performance) responsibility for project coordination through all phases. Typically, **single contractor-centred approaches** allow better time management, buildability, the certainty of price, teamwork and the inclusion of design fees. The effective integration of design and construction is the salient characteristic of the D-B route because of its "single point responsibility". The coordination of all inputs can eliminate conflicts, claims and delays between parties (Dorsey 1997).

However, the D-B route has also resulted in unclear scopes, design changes, communication and coordination lapses and project interface problems with the environment (Chritamara and Ogunlana 2001). In addition, the certainty of price depends on modalities used in a contract and the extent of changes in actual construction. In turn, Atkins and Pothecary (1994) proposed a system based on the UK D-B route and the French "La consultation performancielle". Its advantage is that schematic design, client requirements and performance specification precede contractor involvement. Overall, it can be concluded that integrated D-B forms do not solve all the problems identified within the traditional fragmented procurement routes.

In addition, Atkins and Pothecary (1994) referred to some studies that make a number of proposals for **new espoused procurement systems** permitting the separation of concept design and the delivery of construction product (building). More recently, Cox and Ireland (2002) suggest a range of a supplier's relationships from purely independent, transactional and price-based interactions, via highly interdependent relationships to dependent sourcing arrangements. Nicolini et al. (2001) advocate the use of work clusters with concurrent engineering as an organisational approach to supply chain integration. Kagioglou et al. (2000) suggest fragmented solutions for improving integrated project processes. However, it seems that each new procurement route is creating its particular problems while overcoming the failures of the traditional ones.

In the UK, **the integration of a process and a production team** around the product (building) is one of Egan's (1998) five drivers of change to deliver value to owners. The flexibility of fragmented processes is recognised as an advantage vis-à-vis the discontinuity of teams results in inefficient working. Discontinuity is inherent in one-off projects. Hence, an integrated project process centre is suggested to be formed around the four elements of product (building) development, project implementation, partnering in the supply chain and the production of components. The key premise behind an integrated project process is that teams of designers, constructors and suppliers work together through a series of projects, continuously developing products and a supply chains, eliminating waste in delivery processes, innovating and learning from experience. Partnering is defined as a process that involves two or more organisations working together to improve performance through agreeing mutual objectives, devising a way for resolving any disputes and committing themselves to continuous improvement, progress measurement and gain sharing. In turn, Bresnen and Marshall (2000) postulate that in the 1990s **partnering and collaboration** were seen as a way of dealing with the fragmentation and the lack of integration. In fact, partnering is not limited to a single point of responsibility or D-B forms from the operational point of view.

In Figure 11, **project delivery methods (procurement routes) and project financing methods** are arranged within a 4-quadrant framework in order to position the STO route versus the other procurement routes as follows. On the horizontal axis, procurement routes (delivery methods) are categorised as fragmented (multiple points of performance responsibility) and integrated (single point of performance responsibility). On the vertical axis, project financing methods are direct (e.g. cash appropriations or debt financing) or indirect (e.g. income stream, incentives, debt, equity and bond financing). Problems with the quadrants stem from the fact that many of these routes have more than one basic form and practical applications are often the mixtures of two or more routes.

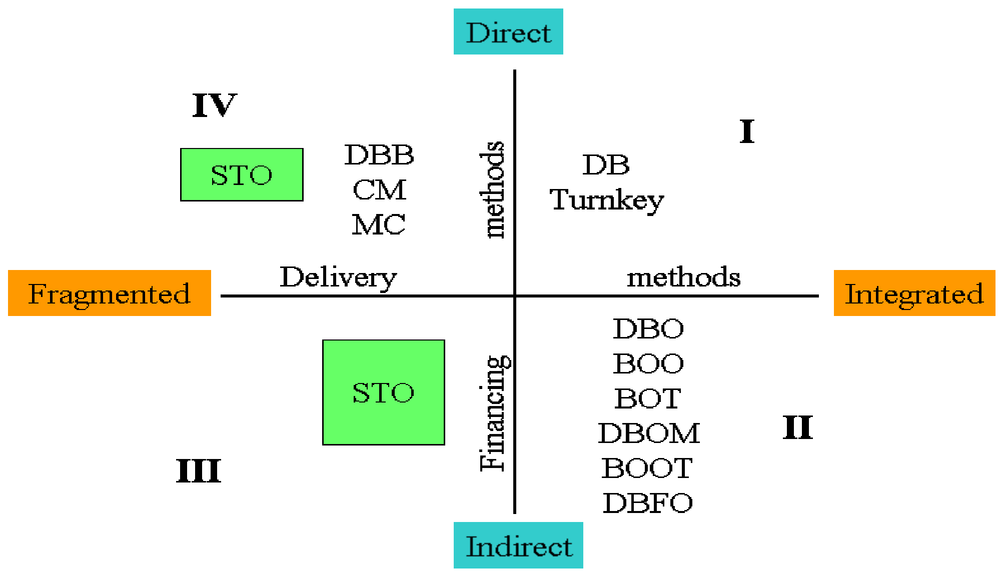


Figure 11. Positioning of the STO route in relation to the key delivery and financing methods (applying Miller 2002)

In comparison, **the fragmented STO route** can be combined with direct or indirect financing due to the involvement of many STOs throughout all phases of project implementation. Each owner can decide on the level of involvement of external markets in terms of developing a project solution that meets his requirements, integrating this solution with STOs and their expertise as well as managing the implementation of construction activities. However, an STO route incorporates also Egan's (1998) premise of **integration within the grouped tasks** of product development, construction/

installation and maintenance. Internally, each direct STO exploits integration processes in carrying out its particular tasks. Several indirect STOs may be chained into an integrated task performance system for a complete delivery of the direct STO's project part from the proposal and design via the delivery and construction to the maintenance of the finished product (building).

4.3 Operational Model of the STO Route

The operational model of the STO route is illustrated through its 11 phases in Figure 12, which is applied to both the experienced and inexperienced owners (clients). In the context of a building project, the route starts with (1) an owner who is identifying his building needs. (2) Thereafter, this owner forms an STO management team of experts with a project manager which guides the owner and manages the project through the remaining phases. (3) Next, the STO management team is augmented with a design sub-team that provides the overall product design, documents and performance specifications. The overall design is used to set the cost plan and the targets for both the total scope and each task. The long design period is cut short as the traditional design and costing is eliminated. More alternative designs from diverging perspectives prepared by one or several experts are also available. (4) The STO team sends out invitations on behalf of the owner to STOs to tender for their parts of the project. The instructions to tenderers (ITT) spell out the project information (general plan, performance and technical specifications), the tender format, the selection and evaluation procedures, the rules for disqualification, the latest date for the notification of intention and the tender submission date.

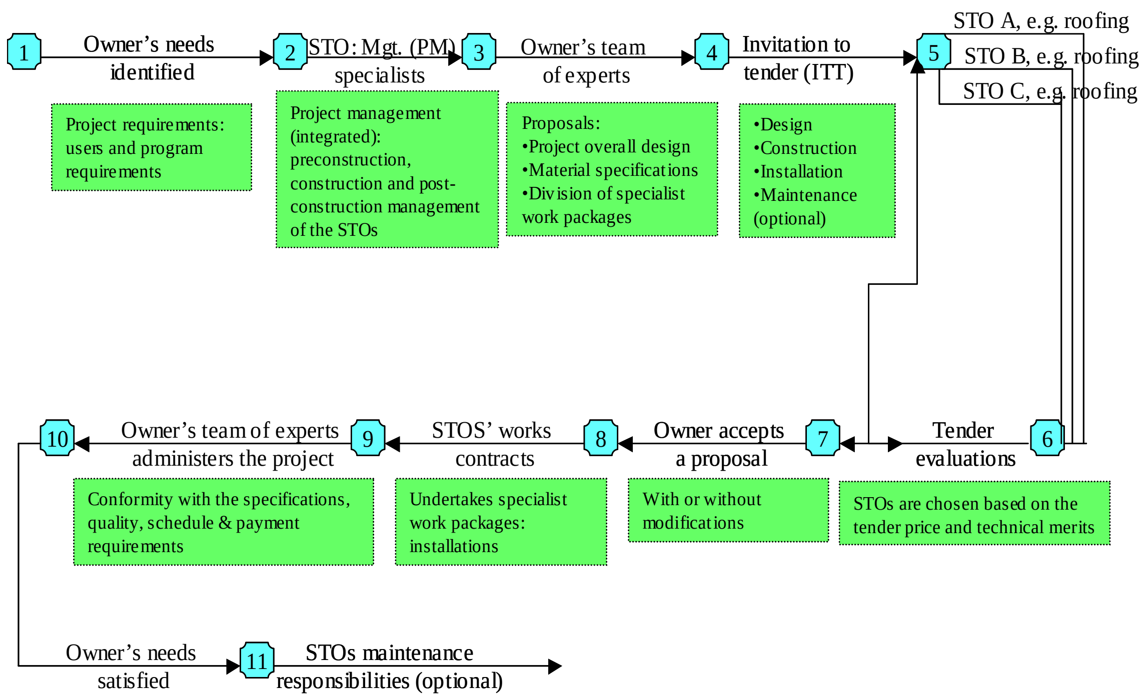


Figure 12. Operational 11-phase model of the STO route

(5) For each main part, multiple competing STOs prepare their tenders in two parts: technical tenders and price tenders. A technical tender contains information on the relevant and specific experience of each STO in similar or related jobs. 5-10 reference projects are required (not older than 5-7 years). In order to have the reassurance on the quality and the adherence to the procedures, each STO is asked to produce the technology/method statements relating to their tasks. Tenderers are required to describe in detail the volume and content of the reference projects, their actual role, involvement and duration (actual working months). The price tender is required to be based on the suggested technical solution.

(6) The STO management team evaluates the tenders by giving the scores to both the technical and price tenders as well as to the completion times in proportions that justify the complexity of the project. Hence, the economically/technically most advantageous tender is selected. An open or close competitive selection process may be used as described, for example, by Poage (1990). Each STO is required to submit a performance statement on how (methods) and when (schedules) to carry out the task with the tender.

(7) In turn, the owner accepts the bid with or without modifications. Besides the price, the STO selection is based on the design/engineering solution, constructability, maintainability, life cycle costs, schedule, stated methods and technical specifications through the closing negotiation with the owner.

(8) In the construction phase, the STO management team integrates the implementation of each STO's package in order to avoid the repetition and duplication of activities and to allow for the exploitation of specialisation. Each STO is requested to submit a tentative programme as part of the tender. The tasks are coded as the key events with the sub-events that are integrated to form the event planning/programme. In order to monitor project progress, a milestone plan is derived from the event plan/programme.

(9) Each STO carries out the construction works (installation) of its package/part in conformity with the technical specifications. Cost control activities are cut down because the STO's solution has been critically reviewed and the fixed price agreed upon which eliminates, thus, future changes, variation and undue claims.

(10) The project close out is carried out by the STO management team after all the STOs have successfully completed their shares of the project. The management team compiles all the necessary documentation from the STOS for the smooth running of the facility. These documents are handed over to the owner. If needed, basic training is given on usage, health and safety, etc. This phase signifies the practical completion of the project. The final payments (minus retention fees) are given to the STOs. The management team communicates the closure of the project to all stakeholders. The management team also provides the formal project hand over report to the owner that includes the post implementation review on overall success, the attainment of the objectives originally stated, the lessons learnt and the deliverables.

(11) STOs may also carry out the related maintenance activities (as an optional service/responsibility. One of the options is to include a maintenance contract or a clause with the specified duration as part of the main contract. The duration should be longer than the period of normal defect liability. The other option is to have a yearly maintenance fee for the life span of the product. Nonetheless, each STO is bound to correct all defects to be found in their work within the liability period.

In Figure 13, **the schedule of the STO route is compared to that of the traditional route**. In both cases, the brief takes the same duration before the commencement of design. In the STO route, the overall design with the specifications is produced in a shorter time. Hence, the earlier commencing of STO works packages takes place. Upon the acceptance of the critical bids, the STOs produce also the detailed engineering drawings that the STO management team integrates into the master schedule. Similarly, the earlier commencing of construction works allows even the fast-tracking and concurrent design and construction works.

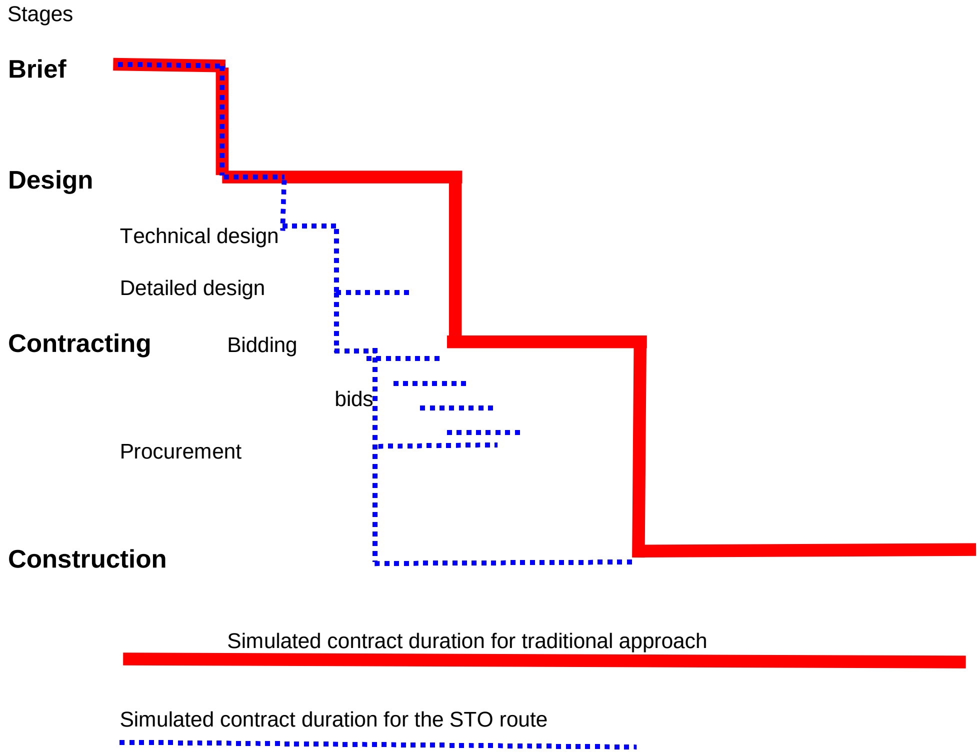
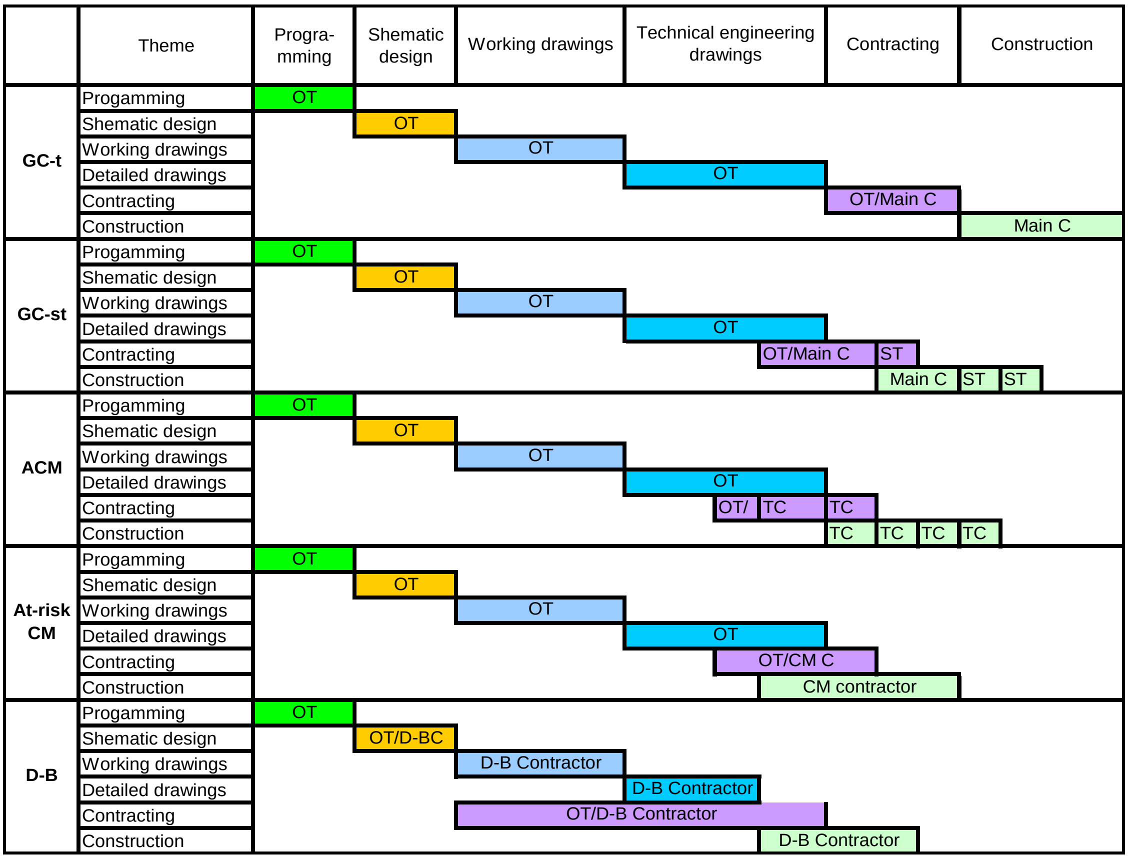


Figure 13. Comparison of the simulated contract duration of the STO route and the traditional approaches (principle)

In Figure 14, **the principal schedule formats of five key procurement routes** are compared in terms of their effects on completion times under the owner team's (OT) guidance. (i) In the traditional general contract (GC-t), each phase is completed before the next one is embarked upon. (ii) In the general contract with separate trades (GC-st), the main contractor's works start earlier followed by separate trades contractors. (iii) In agency CM (ACM), trade contractors start their works earlier than in the GC-st. (iv) In CM-at-risk, a fast-track construction is enabled based on the earlier preparation during the preconstruction phase. (v) In D-B contracting, the contractor involvement starts early in the schematic phase. The actual contracting tasks are run concurrently with the preparation of the technical drawings. The construction works commence after the completion of the technical drawings which shortens the contract duration.



OT – Owner's team; Main C – Main contractor; ST – Specialist trade; TC – Trade contractor; CMC – Construction manager contractor; D-BC – Design and build contractor

Figure 14. Comparison of the principal schedule formats of five procurement routes

In Figure 15, **the principal schedule format of the STO route** is illustrated under the guidance of the STO management team of the owner. The programming is completed before the commencement of the overall schematic design with the performance specifications of the technical and material requirements. The additional construction/site management team may be formed along the division of the work scope to the STOs. The management team reviews all the technical and material requirements in order to eliminate the risks arising out of the blending of the design details. Based on the completed overall design, the procurement of the STOs and their packages takes place. Based on the winning tenders, the successful STOs commence their detailed technical designs and carry out their construction works, concurrently.

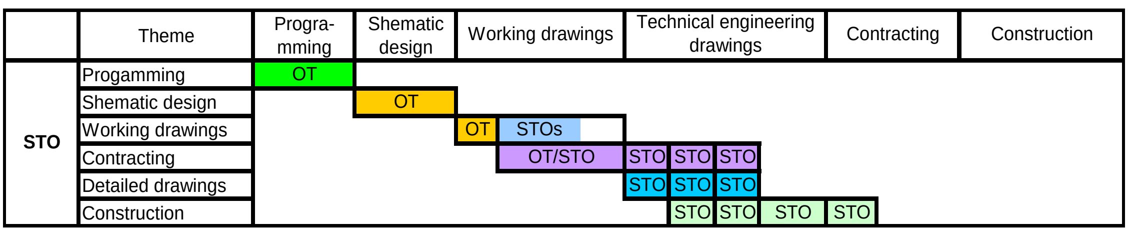


Figure 15. Principal schedule format of the STO route

The schedule advantage of the STO route lies in the fact that the implementation can be managed as a fast track by the specialist task breakdown. The involvement of STOs in the detailed technical design shortens the project period. The management team initiates procurement activities before detailed technical designs. Concurrent design and construction shortens also the period. Early works (e.g. sub-structural works) can be carried out along the procurement and the detailed design of late works (e.g. infill).

4.4 Contractual Arrangements of the STO Route

By project, **the contractual arrangements and the organisation structure** of the STO route are being formed through the owner's decision to establish the STO management team. In turn, this management team carries out all integrative management, coordination and administration tasks as well as gives preconstruction advice on scheduling, budgeting, value analysis and bidding. Instead of the STO management team, the STOs guarantee prices, schedule completions and targeted quality. In turn, the owner enters into the contract with the design team for the overall design and the technical specifications of the proposed scheme. The project scope is then divided into specialist tasks according to project needs. Accordingly, tenders are invited to be submitted by interested competitive STOs. By package, the owner selects the best STO on a basis of all the submitted specialist solutions including the completed designs (engineering design), the specifications of the materials, the fixed costs and the schedules.

In Figure 16, **the contractual arrangements of the STO route** are illustrated. The STO route is based on the following ideas:

- An owner is fully relying on the expertise and competences of an STO management team throughout all project phases.
- A design team is assigned to the development of overall drawings with project requirements as well as material, technical and performance specifications
- A construction/site management task organisation is assigned in order to avoid repetition in administration and supervision, the duplication of equipment and to supervise/coordinate project quality, schedule, cost etc.
- STOs are contracted for each segment of the project scope with their complete detailed (engineering) designs, manufacturing, construction, installation and (optional) maintenance tasks.
- Each of the STOs is responsible for the risk associated with the design, the construction failure and the uncertainty in cost, time and project quality, by segment and subcontract scope.
- Each of the STOs has a direct contract with the owner.

In Figure 17, **an example of one STO with its complete segment of the project scope** is presented in terms of interactive, integrated, independent and interdependent processes. Each STO (segment) bears the risks as well as carries out the integration of its contracting, design/engineering, manufacturing, construction/installation, supervision and maintenance processes. In turn, the STO management team integrates each STO's solution together with those of other parties (e.g. a specialist artist).

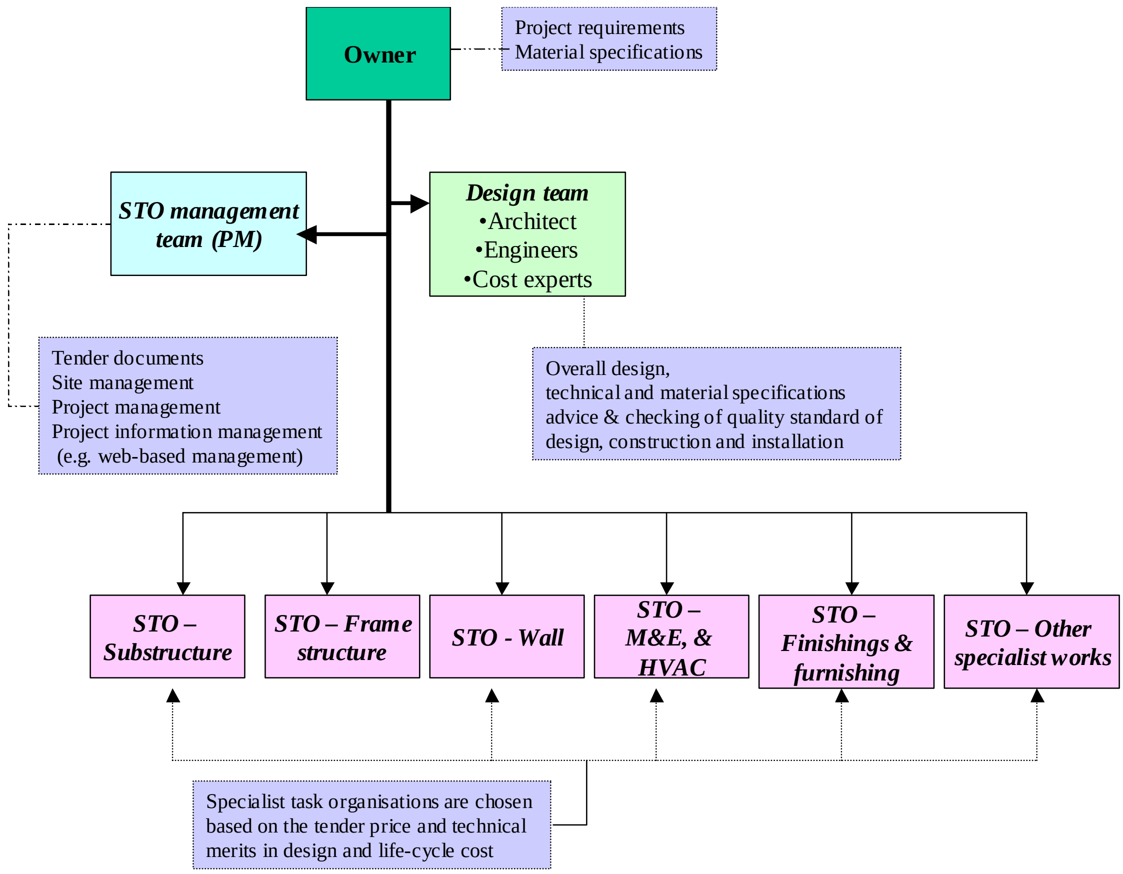


Figure 16. Principal contractual arrangements and organisation for the STO route project by project

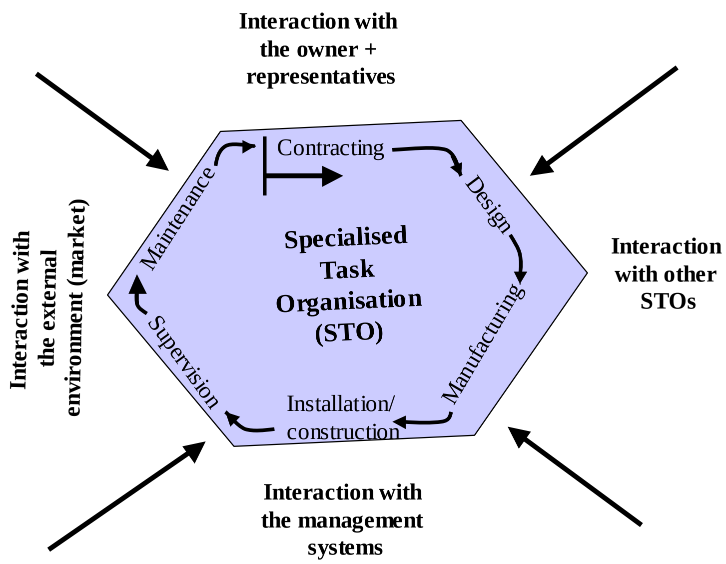


Figure 17. Interaction between the STO and its project environment

4.5 Communication, Coordination and Cooperation along the STO Route

It is vital to bring together all STOs and their project-specific solutions. A STO project manager and his team integrates all parties through project phases. In turn, a design manager administers overall design processes while a site manager manages all site operations, provides site facilities, etc. The involvement of many parties within both value-adding design and construction chains enhances specialisation in the core STO segments or tasks. In this respect, the STO route differs from contractors providing site supervision and facilities along the design-bid-build, traditional D-B and agency CM routes.

For real-time communication, an owner and its STO management team exploit links with STOs enabled by the management information system (MIS) and through the Internet. Each significant change is communicated through the MIS. The management team chooses and specifies the scope of the MIS. In practice, the representatives of professionals and owners only are competent to assess what kind of the MIS will serve them best. At minimum, the relevant project information is fed in, changed or renewed, tracked, acquired, inquired, communicated, stored, managed, shared and retrieved by all project parties anywhere and anytime through the STO-based MIS.

For effective coordination and co-operation, the STO management team guides all STOs via the same MIS as well as each STO can integrate and communicate his final solution with the management team and each other. In contracting phases, STOs submit the required information on their past records and the project in question. In construction phases, the site management team supervises the selected STOS, their works and the site as a whole through the MIS. Real-time communication is ensured among all project parties as well (Figure 18).

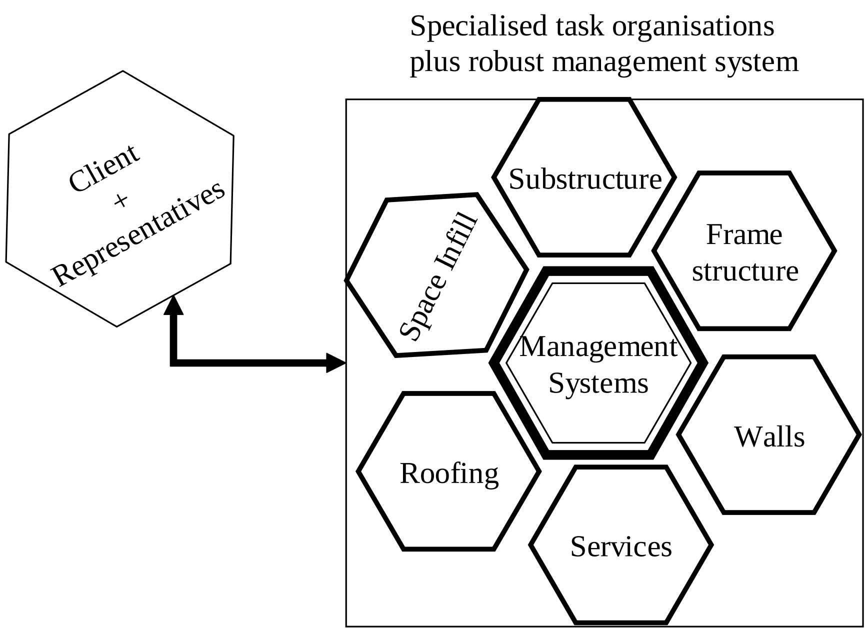


Figure 18. Integrative management system guiding STOs in a building project

In principle, the scope of a new building can be divided into seven segments or tasks that competitive STOs master as follows: (1) sub-structural services, (2) frame construction (core and shell), (3) walls and claddings, (4) mechanical and electrical systems, (5) furnishing, fittings, doors and windows; infill/fit-out, (6) roofing, (7) site services and external works as well as (8) other specialist work (e.g. artwork).

4.6 Risk Allocation, Responsibility Distribution and Compensation within the STO Route

The primary burden of risk on a building project falls between a contractor and an owner (client). Insurers often carry low probability, high impact risks such as fire or collapse (Flanagan and Norman 1993). Along the STO procurement route, an owner holds all primary project risks such as credit, market, liquidity and funding risks. An STO management team bears only risks to be specified in a management services contract. Designers carry normal design-related risks to the level of their design work. The consequences of any innovative design are imposed on designers. Each STO bears risks associated with its detailed engineering, schedule and construction works.

All project parties obtain **the required insurances and bonding.** They indemnify mutually each other against standard claims. The Joint Names Policy is obtained by the parties on the specified peril on existing structures and its contents as well as for the full re-instatement value of the project. STOs obtain their insurances to cover liquidated and ascertained damages as well as general and automobile liabilities. Each project party calculates its target budget for an STO management team and an owner. The latter is responsible for **payments** according to pre-specified milestones. A successful STO is reimbursed with marginal design fees and full construction costs based on the agreed modalities. STOs bear financial and schedule risks in projects. Therefore, their fees are linked to project costs.

Extra earnings or bonuses versus sanctions are incorporated into an integrated set of STO contracts. In the bonus model, the interests of an owner and those of other project parties are harmonised. The agreed bonus is paid to an STO after all its specific objectives in terms of quality, costs, schedule and co-operation are attained. No sole savings are targeted because this policy might influence intentional design changes to decrease a project quality or changes in order to increase a target price artificially. One of bonus models is readily illustrated in Figure 10. This model is also applicable to the STO route in order to motivate designers and STOs, i.e. a bonus is paid to an STO when the packaged specialist task is completed at the lower cost than the target price within the agreed task period while a sanction is imposed on an STO when the task is performed at the higher cost than the target price. The relative bonus and sanction depends on the difference between the target price and the actual price that is shared between the STO in question and the owner, i.e. the STO may receive a bonus of 30-50 % of the saved money or, alternatively, it may have to pay a sanction of 5-10 % of the net cost exceeding the target price. The GMP is also applicable with the STO route, i.e. it is 5-10 % higher than the acceptable target price. If an STO exceeds the GMP, it compensates such an additional cost to the owner.

4.7 Management of Five Value Adding Areas within the STO Route

In the USA, **value management** is defined as a process that provides owners with optimum building projects at minimum costs. It is an extension of value engineering

(VE), value analysis (VA), life cycle costing (LCC) and constructability. Value management is aimed at extracting the optimum overall design, securing an owner's prescribed level of value from design and construction of his project and translating the owner's goals and the project's characteristics into a workable contracting structure (Haltenhoff 1999). Value adding processes cover the PM body of knowledge through project phases in terms of cost versus value, quality versus value, schedule versus value etc. Value management involves a range of structured principles, analytical techniques and innovation practice development.

In Figure 19, **the five value adding areas** within the STO route are illustrated. These key value adding areas were selected through the theoretical analysis of the references on the practices of the USA, the UK, Japan and Finland and, in particular, based on the positive and negative attributes of the contracting practices in these four countries (see Table 1). For instance, R&D adds high value to the Japanese practice resulting in real-time feedback and proactive learning.

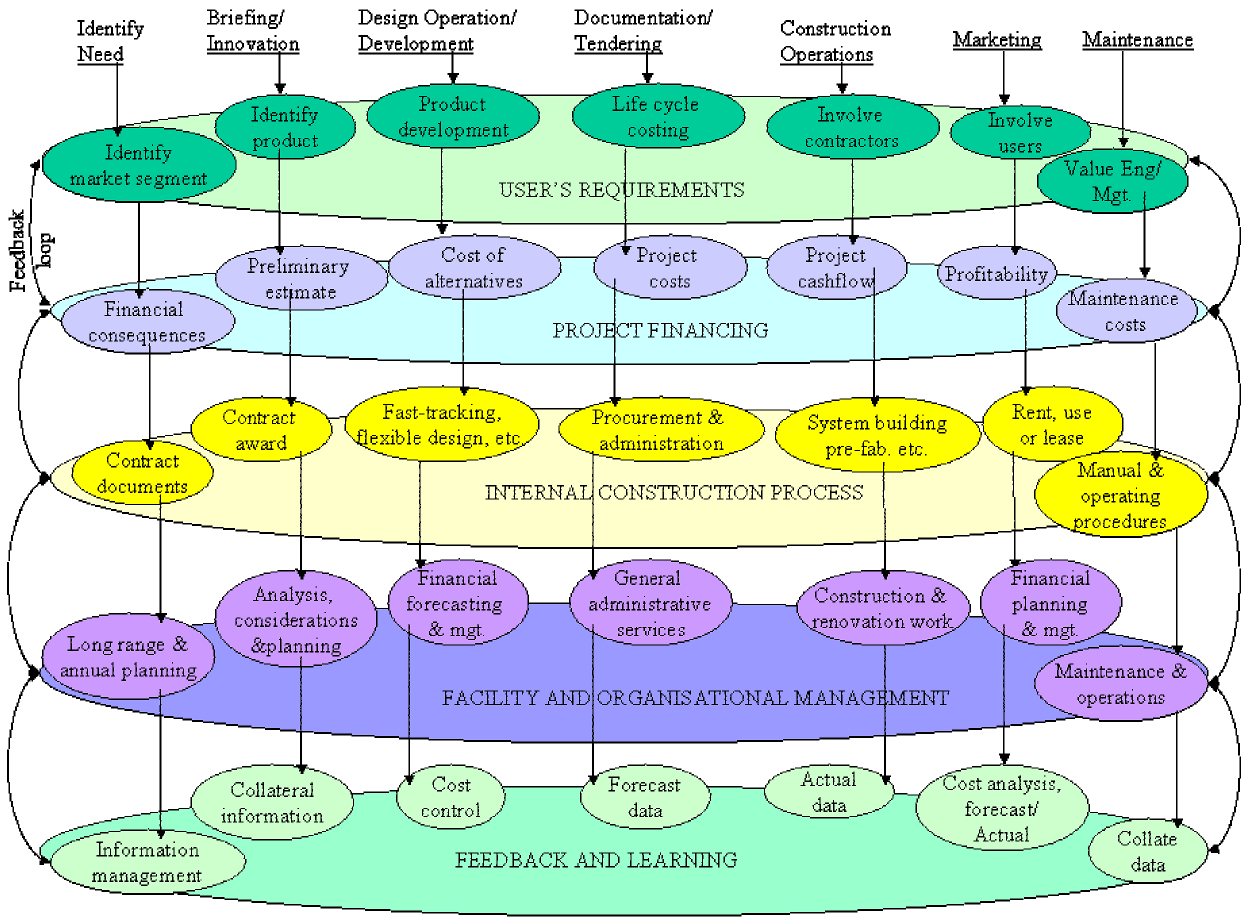


Figure 19. Management of five value adding areas within the STO route

Herein, it is proposed that the adoption of the STO route enhances **a better understanding of ways of achieving higher value for owners' money through five value adding areas** as follows: (i) managing targeted users' requirements better, (ii) managing project financing professionally, (iii) managing internal construction processes more effectively, (iv) providing high-quality maintenance or facility management (FM) services and (v) exploiting real-time feedback and subsequent proactive learning (Figure 19). More value for owners' money needs to be accomplished with the finished buildings/projects. There is a need for an innovative organisational approach in design and construction, and improvements in building maintenance, feedback and learning.

The five value adding areas are managed horizontally (by area) and vertically (across five areas). For example, **vertical interdependences between the five areas of an owner's investment managemen**t involve the identification of market and building segments, the forecasting of financial consequences, the contract documentation in terms of design, contracting and construction methods, the long range and annual FM and organizational planning and the management of all project information.

The basic assumptions on adding value in building projects along the STO route are as follows: (i) Building quality and performance are improved while (a) reducing resources or (b) increasing resources. (ii) Building quality and performance are attained while reducing resources. An increase in satisfying owners' needs must be greater than that of resources used. A cost increase or decrease can be justified in relation to the level of derived satisfaction. An increase in the fulfilment of clients' needs must be greater than that of the resources used.

4.7.1 Requirements of users

Owners (investors) can add value to their projects **by analysing users' requirements** and, thus, facilitating projects that have considerable life cycles. Owners may carry out in-depth research on users' needs, wants, expectations and preferences along dimensions like price, quality, functionality, image, aesthetics value etc. (Czinkota et al. 1996). Building owners expect to become involved in design and construction phases. Time, value for money (to be invested) and low maintenance costs ranked among the most important criteria followed by contract prices (Franks 1998). In the case of both long-term and speculative owners, user requirements form the key factor within an owner's investment strategy, i.e. the rents of users provide revenue streams to finance the project. Hence, users' satisfaction is one of the determinants of project success. Users put projects into effective use. Owner-users want greater value, reductions in capital costs, improvements in quality, reductions in running costs and value improvement and cost reduction through the integration of design and construction.

In fact, **many users cannot determine their requirements** at the onset. In Figure 20, the STO route is shown to allow the involvement of experts at consecutive phases via the separation of the overall design by the design team and the detailed technical engineering by STOs. Instead of programming phases, users' requirements are taken into account in overall design phases and, subsequently, detailed technical engineering phases. In turn, STOs can effectively utilise their expertise in helping users to identify their needs and incorporating these as requirements for detailed technical engineering.

In Figure 21, **the project value perceived by owners** is illustrated as a project's successes and concerns, respectively. They are causally linked to owners' expectations on quality, cost, time, performance, satisfaction, etc. Based on continuous improvement, successes are to be attained (and sustained) while concerns must be solved before the handing-over of the building/project in question. Positive and negative factors are used to measure the accomplished level of value for the money invested by owners.

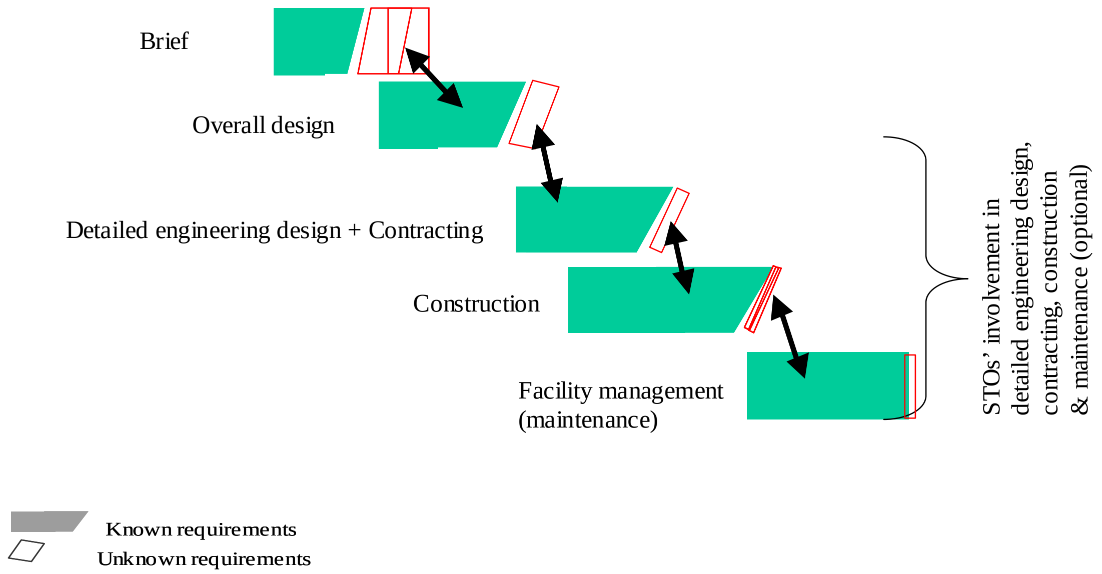


Figure 20. Solutions of the STO route to meet users' requirements

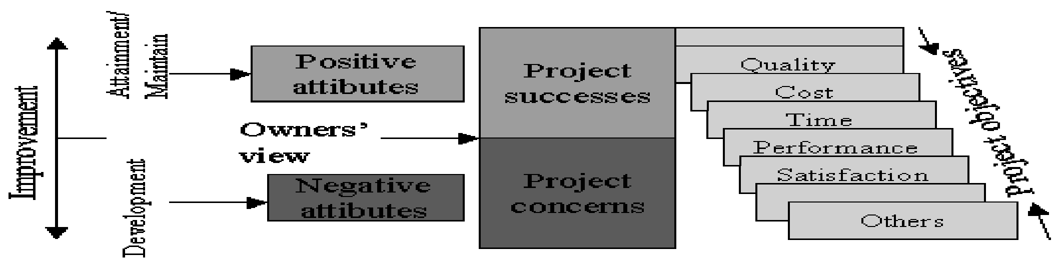


Figure 21. Project value perceived by owners (primary clients)

In addition, an STO management team **coordinates all project requirements,** i.e. users' requirements with site, environmental, and statutory requirements to produce such design requirements that in turn create construction requirements that guide actual construction works. In a project development/building design phase, a management team engages designers, STOs and users in a project so that constructability and uses are taken into account. Users become involved in project inception phases whenever this is possible. The early involvement results in greater flexibility during later phases.

The STO management team exploits cost planning to minimise the costs of construction and usage as well as to maximise the building functionality. Because of the growing importance of building usage and maintenance (e.g. energy), the traditional cost planning has been metamorphosed into **life-cost planning** (e.g. Life Cycle Costing, LCC) by taking into consideration the technical inputs of the life cycles of elements, materials equipment. Cost and other design criteria are integrated through sophisticated modelling techniques (Best and Valence 2002, Langston 2002).

4.7.2 Project financing

In principle, the STO route does not differ markedly from the prevailing procurement routes in terms of project financing. To most owners, **the primary objectives of project financing** include increasing revenues, improving productivity, enhancing asset utilisation, decreasing costs and reducing risks. Typically, financial project performance is measured by the return on capital to be employed (ROCE) and the return on investment (ROI) or by the cost of realising the project. Project cash flows in construction phases, profitability in market terms and maintenance costs are targeted to avoid abandonment, excessive over budget, claims and other project concerns (Pilcher 1992).

Alternative project financing strategies involve direct or pure financing by owners through own reserves or via private commercial banks, development banks, investment companies or finance corporations in terms of commercial loans, public funding, borrowing/buying on credits, trade credits, overdrafts, equity stakes and guarantee trusts, bonds and equity financing, commercial papers, Eurobonds, Sterling issues, private placements, deep discounts, zero-coupon instruments and preference shares (Beveridge 1991, Langford 1995, Low 1996, Brealey and Myers 2000). In turn, off-balance sheet financing does not allow any recourse to owners (Ong and Lenard 2003). In addition, joint venture partners may provide investors with equity funding during development phases (Miles et al. 2000).

4.7.3 Internal process management

Along the STO route, **the management of a project's internal processes** deals with innovative building design, contracting and construction processes. Overall, an owner and an STO management team are encouraged to ensure the satisfaction of other project parties, i.e. designers and STOs in terms of support, attitude, understanding, the high quality of a brief and the attractive financial aspects of performance. In particular, the capacity of a management team as well as an owner's past performance, experience, financial soundness and reputation influence satisfaction levels among STOs; e.g. aligning with Soetanto and Proverb's (2002) study on contractors' satisfaction.

Design process management is herein emphasised in terms of guiding a network of design tasks embedded with internal constraints (e.g. the use of particular materials or technologies) and external constraints (from an owner's needs, technology, construction process and statutory control) (Gray and Hughes 2001). The STO route enhances flexible open-ended design to allow easy conversion, life cycle costing, value engineering and alternative FM solutions. It balances statutory body regulations, design rules, owners' pragmatic needs and aesthetics. Highly flexible (sub)solutions are enabled by cutting down rigid process dependencies (Kiiras and Kruus 2005).

For **contracting process management,** a STO management team relies on pre-qualification exercises, pre-tender planning, tender invitations and tender estimation techniques. Each of STOs can utilise the overall design in order to produce its detailed engineering solution coupled with the aspects of both construction cost estimation (price) and life-cycle management. This innovative fragmented procedure may well shorten construction times and reduce costs, too. The management team guides STOs to co-operate for achieving high design and construction compatibility. This encourages partnering, trust building, dispute resolutions as well as technical and social integration.

In turn, **construction process management** is relying in particular on cost planning techniques for producing high value for owners' (clients') money through all project phases and processes (Figure 22).

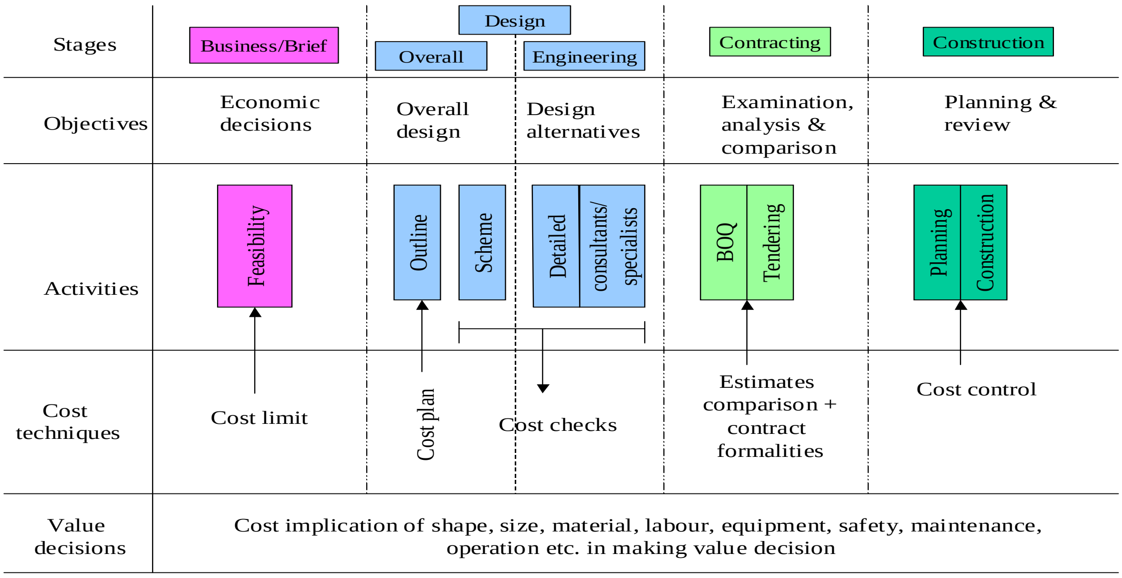


Figure 22. Use of cost planning techniques for value engineering decisions along the STO route

4.7.4 Facility management

Facility management (FM) includes hard and soft services, i.e. technical services and supporting services in enhancing the performance of the building or facility in question, respectively. The responsibilities of a facility manager include long-term and annual facility planning, facility financial forecasting, space management, renovation planning, maintenance and operations management, telecommunications integration as well as security and administrative services (IFMA 2003). FM is coupled with all kinds of workplaces (e.g. commercial, industrial, medical and educational facilities). FM and business support functions can be integrated into a workplace network that involves a FM team, specialist service providers and end-users. There is a need for workplace network management via formal interaction in order to strengthen multi-level co-operation (Tuomela 2005).

Along the STO route, an owner is taking the final users of a facility into account very early. In addition, an owner is advised (by the STO management team) to procure **the initial long term and annual facility operations and services plans** from among specialist facility services organisations (SFSOs). In turn, a STO management team coordinates and compiles all FM manuals, operations and uses procedures, spare parts, warranties. The same team acquires all permits before, during and after the project completion. Optionally, future facility services can be contracted from among SFSOs.

4.7.5 Feedback and learning

Herein, Koskela's (2003) cybernetic and scientific experimentation models of control are considered as the exemplary basis for **managing project feedback and project party learning** along the STO route. The standard of targeted high performance is defined, the actual performance is measured through the output by project (sub-)phase and the possible variance between the standard and the measured value is used for correcting the project process so that the standard can be achieved. Primary control tasks are performed readily in planning phases where causes of deviations are identified and acted upon. Feedback loops for each task are short to allow immediate remedial actions, thus adding the aspect of learning to control. Feedback information is also needed for future learning among project parties.

Along the STO route, a management team is responsible for the storage, retrieval and dissemination of information during all project phases. For example, short feedback loops allow utilise the status of the preceding contracted STO packages for **managing the remaining STO packages**.

In Figure 23, **the concept of value adding** is illustrated by project phases along the STO route. In the prevailing procurement routes (e.g. D-B), the maximum value to be attained for each phase is fixed before proceeding to the next phase because each phase must be completed before proceeding to the next one. In principle, the completeness of design documents before the construction phase is adhered to safeguard project parties against any uncertainties in cost, schedule and quality. In practice, several uncertainties turn out to emerge as risks that are being encountered through claims, additional works, variations, disputes etc. Naturally, as a progress is made in a project value chain (phase milestones are reached), value is added to the process, resulting in a phase higher than the previous phase. If the process is fast-tracked as in a CM contract, the effect of short feedback loop reveals a value loss in the traditional approach and a value addition in the fast-track approach as the result of a short project duration and subsequently a saving in project cost.

Moreover, further savings are made as the STO route exploits **progressive tasks** via bid packages, commences the first construction works very early, monitors costs and sorts out the most viable solutions from among competing bid packages. Concurrent design and construction add more quality value when all STOs are involved in the same phase and they control the inputs and outputs of the design and construction tasks, concurrently. In comparison with the prevailing procurement routes, building owners enjoy **higher added value** along the STO route through the combined outcome of:

- Early availability of information from preceding tasks, i.e. short feedback loops
- Improvements based on expertise knowledge
- Immediate feedback on the performance of tasks under execution
- Short feedback loops
- Improvements in building quality via healthy competition based (besides prices) on different designs, life-cycle costs, materials, construction means, techniques and technology
- Immediate monitoring of actual costs, schedule and quality
- High certainty of the scope of each task is ensured during detailed engineering phases, which reduces claims, disputes, variations, extra works etc. in later phases.

In Figure 24, **the amount of a loss of value by project phases**, under the prevailing procurement routes, is demonstrated through a triangular graphic expression (corresponding to each phase in Figure 23). The horizontal line denotes the value achieved in each phase while the vertical line represents the value added from the preceding phase to the next one(s).

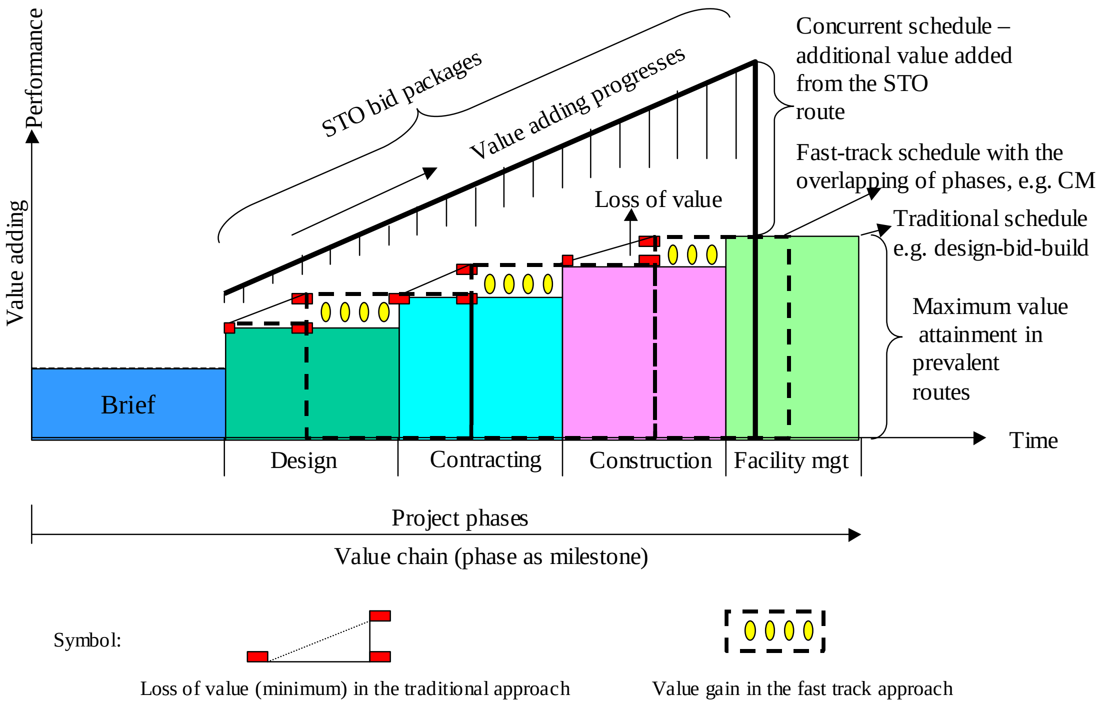


Figure 23. Concept of value adding by project phases along the STO route

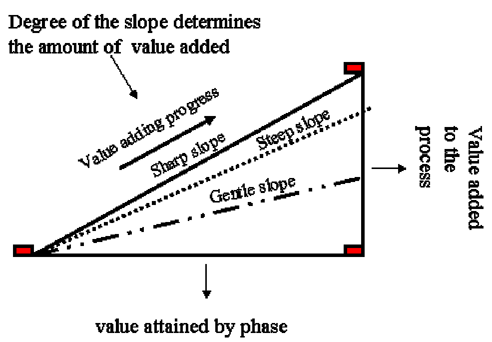


Figure 24. Loss of value in prevailing procurement routes due to flat feedback slopes

The nature of the feedback slope (sharp, steep or gentle) determines the amount of a value achieved by each phase as well as the cumulative amount of value to be added to the project process as a whole. In principle, the attainment of the maximum value at each phase assists in maximising a value set for the next phase and eliminates gaps between the project requirements and the subsequent, associated losses.

4.8 Some Anticipated Constraints Related to the Adoption of the STO route

There are several constraints that can hinder the adoption and use of the proposed STO route. In principle, **any new route** will be first met with mental resistance among decision makers. Typically, Whyte et al. (2002) emphasise this adversarial aspect within the culture of the construction industry along its apathy to change.

In addition, the critics might argue that the STO solution will amount to extra costs in contracting and design as each STO becomes involved in these tasks. However, the STO route amounts to no such extra costs when the designers in question rely on standard building solutions, products and their common dimensions. Thus, extra man-hours allocated for detailed engineering among STOs are negligible compared to each STO's profit margin. The STO route takes care of custom-built projects through the early involvement of STOs.

Finally, it is argued that **the new STO route will be ranked higher than, for example, CM procurement routes** against the setting and the attainment of project objectives in terms of quality, time, costs and risks. This is so because the STO route can be fast tracked and many activities can be carried out concurrently. Project costs can also be reduced by a process of shop bidding from among many STOs. The STO route eliminates non-value adding costs and the unnecessary layers of profit capturing. The targeted building/product quality and the project performance are ascertained by STOs. In addition, double insurance costs are avoided among STOS when owners (clients) assume all-encompassing forms of liability, i.e. insurance and bonding policies.

5 VALIDATION OF THE SPECIALIST TASK ORGANISATION (STO) ROUTE

The validation of the proposed STO route consists of the theoretical validation (the mapping of the STO route against the selected organisation theories), the empirical validation (the project case survey/questionnaires), and the analogical validation (the case study examples) as follows.

5.1 Theoretical Validation of The STO Route against The Organisation Theories

This section examines the theoretical validity of the STO route by mapping it together with the four prevailing procurement routes against the selected organisation theories, i.e. the organic theory and the bureaucracy theory. Essentially, procurement routes are herein viewed as the economic and interactive organisational setups of project parties.

Donaldson (1988 and 2001) are relied upon as the primary generic reference. **A contingency** is a moderator or a conditioning variable that moderates the effect of an organisational characteristic on an organisation's effectiveness or performance. In the same vein, **organisation theory** deals with formal and informal organisation structures, strategy, power, authority and influence, bureaucratisation, professionalisation, democratisation and the impacts of changes in **contingencies** such as size, technology, task, uncertainty and public accountability. An organisation may be defined as a coordinated action between people and firms, comprising a set of roles and responsibilities oriented towards securing or attaining an objective within its legal boundary. An organisation is a system of interlocking roles. Some roles are codified, formalised, autonomous and participatory based on the rules, regulations and standard procedures. Organisational management addresses goal-oriented behaviour and co-ordination among individuals as well as many attributes such as the degrees of differentiation/separation and concentration/integration mechanisms, the extent of the concentration of authority and the power of stakeholders, communication/information flows, legitimacy and conflict resolution.

There are two main contingency theories of an organizational structure. **(i) Organic theory** states that mechanistic structures with centralised (in decision making), formalised (rules and documents), top-down decision making fits situations of high task certainty and specialised roles, whereas organic structures with decentralised, un-formalised, bottom-up decision making fits situations of low task certainty and low specialisation such as innovation. **(ii) Bureaucracy theory** argues, in turn, that structural formalisation is accompanied by decentralisation. This theory states that simple structures with centralised un-formalised decision making fits situations of low task certainty and functional specialisation, whereas bureaucratic structures with decentralised formalised decision making fits situations of high task certainty and high functional specialisation (Mintzberg 1979). A particular organisation can lie at any point along a continuum of organism and bureaucratisation (Child 1972).

In Table 8, **the five factors,** i.e. centralisation, formalisation, task, specialisation and functions with control determine the organisational structure types vis-à-vis the organic theory and the bureaucracy theory. The similarities and differences between the four structures are as follows: decentralised organic structures and centralised simple structures are both low on specialisation and formalisation. In turn, centralised mechanistic structures and decentralised bureaucratic structures are both high on formalisation and functional specialisation. The task contingency is composed of task certainty and task interdependence. Task certainty is the main contingency of the organic theory, while the size contingency is the main contingency in the bureaucracy theory. Task interdependence serves as a minor contingency in the two theories.

Table 8. Five contingencies affecting organisational structure types within the organic theory and the bureaucracy theory (Donaldson 2001)

Theme	Two main organisation theories			
Main types	Organic theory		Bureaucracy theory	
Subtypes	Mechanistic	Organic	Simple	Bureaucratic
Centralisation	Centralised	Decentralised	Centralised	Decentralised
Formalisation	Formalised	Un-formalised	Low on formalisation	High on formalisation
Task	High task certainty	Low task certainty	Low task certainty	High task certainty
Specialisation	High on specialisation	Low on specialisation	Low on functional specialisation	High on functional specialisation
Function and control	Clear job descriptions	Self-directed team	Direct maximum control	Indirect sufficient control

Overall, organisational structures need to be adapted to **changes in direct primary or secondary contingencies** in order to sustain high performance. Moreover, organisational structures must fit the principal contingencies of a company, i.e. its strategy and environment. Each of these contingencies affects the particular aspect of a structure. A change in a strategy results in a change in a structure. Over time, a company manages its organisational alignment process with the changes of each of contingencies. In other words, there is no single best organisational structure. The driving force is a fit between a strategy, an environment, organisational contingencies and a structure. A fit improves a company’s organisational performance while a misfit lowers it.

In Table 9, **the four procurement routes plus the suggested STO route and their principal project organisation types** are mapped against the four contingent variables of organisational structures. The prevailing procurement routes are grouped in the four categories because this theoretical validation is based on a dichotomy of fragmentation and integration. In other words, each prevailing procurement route implies either an integrated or fragmented project organisation. For instance, all CM routes are fragmented. Instead, the STO route is exploiting a combined (integrated and fragmented) project organisation. Each of five procurement routes is assigned with the following organisational attributes:

- **The BOT route** is where the private sector finances public projects and places design, construction, maintenance and operational responsibilities within its organisation. The BOT routes involve many stakeholders from financing through construction to facility management. Companies work together in a highly centralised way as a consortium forming a single company or operating as a differentiated single entity under the same centralised BOT project operation. At preconstruction phases, BOT tasks are highly certain as different factors like concession, lease conditions and revenue generation, owner's and project requirements and project viabilities are assessed and agreed upon before the major work is initiated. Therefore, the BOT route belongs to integrated organisations, i.e. it is highly centralised within a project vehicle, highly formalised, with high task certainty, low on functional specialisation, with clear job descriptions and maximum direct control.
- **The D-B route** is where owners contract with single entities to perform both design and construction under a single D-B contract (Sanvido and Konchar 1999). The D-B route relies on an integrated project organisation which is centralised, formalised, with low task certainty, low on functional specialisation as well as with self-directed teams and direct maximum control.

Table 9. Mapping of five procurement routes and their project organisation types against organisational structures

View	Procurement Routes and Their Project Organisations				
Main types	Integrated		Fragmented		Combined
Subtypes /Routes	BOT	D-B	Traditional	CM	STO
Centralisa-tion	Highly centralised	Centralised	Decentralised	Decentralised	Decentralised
Formalisa-tion	Highly formalised	Formalised	Formalised	Highly formalised	Highly formalised
Task	High task certainty	Low task certainty	High task certainty	High task certainty	Low task certainty
Speciali-sation	Low on functional specialisa-tion	Low on functional specialisa-tion	Low on functional specialisa-tion	High on functional specialisa-tion	Very high on functional specialisation
Function and control	Clear job descriptions and maxim-um direct control	Self directed team and maximum direct control	Interdepen-dent functions and direct maximum control	Interdepen-dent functions and indirect sufficient control	Interdependent functions, clear job descriptions and self-directed teams

- **Traditional design-bid-build route** is where owners contract separately with a designer and a contractor. An owner contracts first with a design company to provide ‘complete’ design documents. Thereafter, an owner or his agent solicits fixed price bids from contractors to perform the work. One contractor is usually selected and he enters into an agreement with the owner to construct a building in accordance with the plans and specifications (Konchar and Sanvido 1998). Hence, the traditional routes exploit fragmented management systems and project organisations that are decentralised, formalised, with high task certainty, low on functional specialisation and with interdependent functions and direct maximum control.
- **The CM route** is where owners rely on the relationships through several prime contracts between: an owner and an A/E, an owner and a CM company, and an owner and trade/work contractors. The CM routes exploit fragmented project organisations that are decentralised, formalised, with high task uncertainty, high on functional specialisation as well as with interdependent functions and indirect sufficient control.
- In turn, **the STO route** as a whole belongs to bureaucracy setups within the organisational spectrum. The more bureaucratic a system is, the more specialised it becomes, i.e. low on centralisation and high in divisionalisation. The STO route exploits a combination of integrated and fragmented organisational aspects at two levels of project implementation. An STO organisation shares the following attributes as a project organisation structure: centralised, formalised, with low task certainty, very high on functional specialisation as well as with interdependent functions, clear job descriptions and self-directed teams. The number of workforce (size contingency) is minimal compared to the prevailing routes as experts are involved by task category, tasks are well-defined with the shortest possible throughput times and, overall, an STO project is highly specialised in particular when prefabricated elements are relied upon in building construction.

The STO route follows the concept of divisionalisation, i.e. the management of the project as a whole remains centralised whereas task performance responsibilities are decentralised among STOs. Within the STO route, the management team as an integrator coordinates tasks among STOs. The STO route is mapped in more detail at the two levels as follows (Table 10).

The integrated upper organisational structure of the STO route consists of an STO management team is high on formalisation in terms of the document control of project development and building design processes on behalf of the owner (client). This self-directed management team involves high task certainty, high functional specialisation, clear task descriptions and maximum control. Self-direction also absorbs the impacts of uncertainties that are likely to emerge from within a project environment. The management team integrates many STOs and encourages co-operation, co-ordination and easy communication through a centralised management system.

In turn, **the fragmented network of STOs** is decentralised (authority and responsibilities) and high on formalisation. The network involves (a) low task certainty in preconstruction phases due to the contracting of competing STOs based on the overall design only and (b) high task certainty in a construction phase as a result of the early STO involvement in project development and building design.

Table 10. Combination of the integrated and fragmented organisational aspects within the STO route

Theme	Integrated upper organisation (the STO management team)	Fragmented network of STOs
Centralisation	Centralised	Decentralised
Formalisation	Highly formalised	Highly formalised
Task	High task certainty and independent task	High task certainty, both high on task interdependence and high on task-specific independence
Specialisation	High on functional specialisation	Very high on functional specialisation
Function and control	Clear job description and self-directed team with maximum control	Clear job descriptions and self-directed teams with sufficient indirect control

The network is very high on functional (packaged) specialisation. The network involves **interdependent** tasks that STOs perform concurrently. The network is guided through many integrative devices and mechanisms of the upper organisation structure. The fragmented network allows also each STO and its self-directed team to perform the given task (package) **independently** based on the clear package description and the own organisational resources with sufficient indirect control. The STO management team integrates a set of technical engineering and design processes that take place within each STO. After the construction start-up, the same team manages the fragmented project implementation, i.e. the tasks to be carried out by the STOs.

Fragmented project processes are likely **to be managed more effectively** (i) based on high task uncertainty and highly interdependent functions, (ii) in bigger building projects and (iii) in a national practice where technological progress has been advancing in terms of building products and related construction equipment (standardisation) as well as construction means, methods and techniques in general. For example, building products are highly standardised and prefabricated through industrialised building production techniques in the Finnish practice.

In general, the greater the differentiation is among units, the more integration is required to ensure the effectiveness of the organization (Lawrence and Lorsch 1967). This axiom seems to be applicable to focal projects where STOs are carrying out the divided construction works. Within a formal STO project organisation, a set of conditions of contracts spells out the legal parameters for the STOs to execute the project. In turn, Kagioglou et al. (2000) warn us that the improvement of the effectiveness of construction industries trough learning from manufacturing industries (as proposed e.g. by Egan) should be treated with caution. Many disabling differences can be identified between the levels of maturity in strategic and operational management, processes, practices, structures and the organisation of project personnel. In the same vein, Kagioglou et al. (2000) refer to Koskela (1992) and Cooper et al. (1998).

5.2 Empirical Validation of The STO Route through the Project Case Survey

The empirical investigation of the validity of the proposed STO route is herein reported in terms of how the project case survey as conducted, what kind of organisations, respondents, project cases and procurement routes were addressed, what kind of project parties and their contractual arrangements were involved, what overall project performance was achieved, how well project schedules were managed, what roles the design and engineering management played and how well the relationships between the project parties were developed and managed. Finally, the summary includes the partial results supporting the adoption and the high applicability of the STO route versus the partial results supporting the exploitation of the other routes.

5.2.1 Conduct of the project case survey

The building sector in Finland was chosen as the national context for the project case survey due to the author's long-term presence and the access to both local informants and project documents. In addition, the characteristics of the Finnish procurement routes are very similar to the practices within the two exemplary countries, the USA and the UK (Oyegoke and Kiiras 2006). The empirical validation of the proposed STO route was carried out in a form of a project case survey with the subsequent interviews between June 2004 – December 2005.

The twofold aim was (i) to reveal the organisational setups and the involved parties' task-level performance in the project cases, ex post, along the five prevailing procurement routes (traditional general contracting, general contracting with separate trades, CM contracting, CM consulting and D-B contracting) and the perceptions of the key project parties in the building sector in Finland as well as (ii) to identify the aspects of managing the project cases under one of five prevailing routes that also support the adoption of the STO route (vis-à-vis the prevailing procurement routes themselves).

The author developed **the preliminary questionnaire** for addressing the STO route only. However, this STO-focused survey had to be abandoned due to a lack of responses. Thereafter, the original questionnaire was modified to accommodate many additional questions serving also the collaborative FinSUKE study. The trial questionnaire was translated into Finnish, tested among the five professionals (2 scholars, 2 consultants and 1 contractor) and finalised slightly according to the test results. **The final project case questionnaire** enabled the gathering of both the factual data and the more subjective perceptions from among the eligible project parties. The questionnaire consists of six parts:

- Part 1. General respondent information. Respondents were asked to provide general information for data classification, i.e. personal information, practice type, discipline, contractual arrangement, personal role in the project case and interest in a follow-up interview.
- Part 2. Project case description. Respondents were asked to share their experiences from their most recent completed project by stating project name, year of completion, floor area, project type and special features.
- Part 3. Project case parties and processes. Respondents were asked to specify the organisation that carried out the different tasks, their contractual relationships and the compensation method.

- Part 4. Project case schedule. Respondents were asked to draw the actual project schedule at the level of the project tasks in order to reveal the temporal nature of the project case (e.g. fast-track, concurrent design and construction or traditional general contracting).
- Part 5. Project case design and engineering. Respondents were asked to specify the organisation that carried out the identified tasks, its involvement in the design and engineering and the contractual relationships. In particular, this part allows determine the correspondence between each project case and the STO route.
- Part 6: Project case parties relationships and performance. Respondents were asked to measure the level of the relationships (communication), co-ordination and co-operation) between the parties and the project performance.

The organisations targeted by the survey include the ones that enter into contractual arrangements between project parties in building projects under the prevailing procurement routes in Finland, i.e. owners (clients), designers, CM consultants, CM contractors, contractors and building product suppliers. Hence, **a sample** of the eligible professionals employed by such organisations consists of 30 participants in the FinSUKE research project and 11 other contracting, procurement and project managers. The latter were selected from among the experienced managers applying the national certification of their status as the highly professional managers. In order to balance the proportion of variables used, the 10 additional questionnaires were distributed focusing mainly on D-B routes.

Overall, the project case questionnaires were distributed to 51 professionals. 42 professionals responded before the closing date. Thereof, 24 respondents were related to the FinSUKE project participants. Due to the insufficiency of the submitted data, 7 questionnaires were discarded from the analysis. In other words, **35 (69 %) project case-specific questionnaires** were eligible (Table 11). In addition, **the semi-structured follow-up interviews** were carried out among the respondents in order to explore further and to clarify some of the key issues inherent in the questionnaires as well as to obtain the additional relevant information. Initially, 27 respondents agreed upon to participate in the follow-up interviews. In reality, 20 (39 %) respondents were interviewed. In other words, the time constraints resulted in the non-actualisation of 7 interviews.

Table 11. Questionnaires distribution, the responses and the follow-up interviews

Targeted professionals related to building projects in Finland	**No. (%)**
Total number of the questionnaires distributed	51
Total number of the responses received	42
- Number of the responses discarded	- 7
Number of the responses eligible for the analysis Share of the responses	35 (69 %)
Number of the follow-up interviews among the respondents Share of the interviewed respondents	20 (39 %)

In Figure 25, the distribution of 35 respondents is shown **by the project party type**: 9 (26 %) contractors, 8 (23 %) building designers (including 4 architects), 8 (23 %) CM/project managers, 7 (20 %) clients/owners and 3 (9 %) building product suppliers. All the respondents held the positions with high project related authority and decision-making power in their organisations. The respondents have gained the extensive experience from the exploitation of several procurement routes.

Each respondent was guided to choose **her or his most recent building project** as the eligible project case. Overall, the 35 project cases have been implemented between the years 1999 and 2005. Each response was analysed and sent back to the respondent for possible corrections in order to eliminate the threat of any misunderstandings. Some respondents made only the minor clarifications and changes to their responses before the survey data were used for the analysis. Similarly, the interview memorandums were sent back to the interviewees for corrections before the actual analysis.

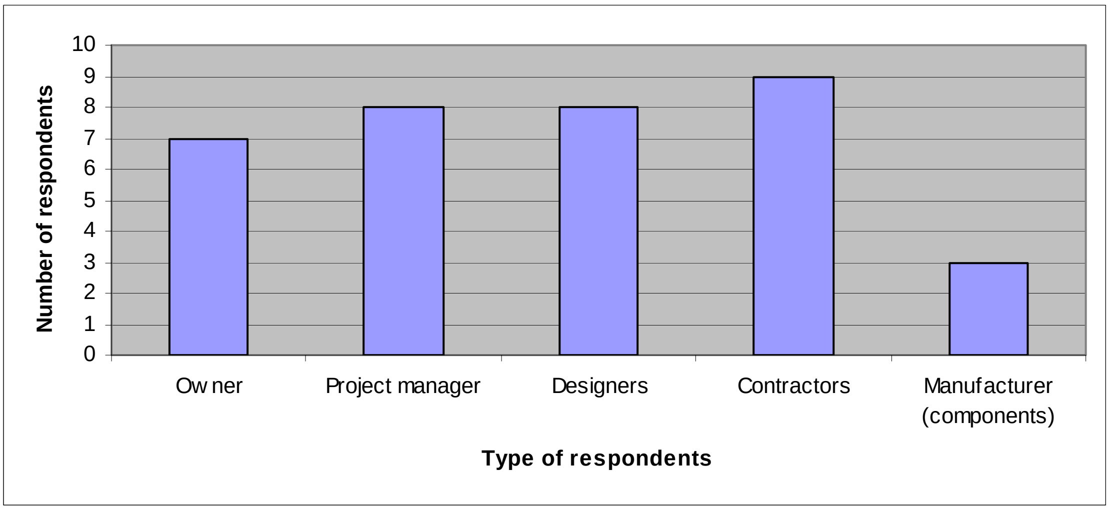


Figure 25. Distribution of the respondents by project party type (n = 35)

In Table 12, **the frequencies of the procurement routes** are shown among the 35 project cases. Within 8 (23 %) traditional general contracts, a general contractor was employed as the main contractor to carry out the works). Within 6 (17 %) general contracts with separate trades, a general contractor was employed to participate in the construction works and to coordinate the works of the prime/separate trade contractors. In turn, 15 CM project cases included 8 (23 %) CM consulting (for fee) contracts and 7 (20 %) CM contracting (at-risk) contracts. In addition, there were 6 (17 %) D-B contracts where a D-B contractor relied on the design firms to produce the design solutions and documents.

A range of the building types consisted of factories, parking facilities, laboratory and research buildings, multi-storey apartment buildings, industrial buildings, public buildings, one stadium and one building for handicap services. Some old buildings were renovated, refurbished and conversed. For example, one industrial building was turned into the office building and one railway station was turned into the office building.

Table 12. Frequencies of the procurement routes among the projects (n = 35)

Procurement routes	**No.**	**Percentage**
General contract – traditional	8	23 %
General contract - separate trades	6	17 %
CM consulting contract	8	23 %
CM contracting contract (including risk taking)	7	20 %
D-B contract (including package deals)	6	17 %
Total	35	100 %

In Table 13, **the distribution of the building sizes** among the 35 project cases is shown in terms of gross floor area. 12 (34 %) buildings include less than 3000 sqm, 9 (26 %) buildings include 3000 - 6000 sqm, 7 (20 %) buildings include 6001 – 10000 sqm, 6 (17 %) buildings include 10001 – 15000 sqm and 1 (3 %) building is about 26000 sqm.

Table 13. Distribution of the building sizes within the projects (n = 35)

Gross floor area (sqm)	**No.**	**Percentage**
< 3000	12	34 %
> 3000-6000	9	26 %
6001-10000	7	20 %
10001-15000	6	17 %
> 15000	1	3 %
Total	35	100 %

In Table 14, **the combined distribution** of 35 project cases is shown by the gross floor area and the procurement route type. There are 1-4 projects in each category except in GC-st in (3001-6000), GC-t (6001-10000), D-B contractor (10001-15000) and all the routes in category >1500 except in CM contractor.

Table 14. Distribution of the projects by building size and procurement route (n = 35)

Route		**Gross floor area (sqm)**				
Type	**No.**	**< 3000**	**3001-6000**	**6001-10000**	**10001-15000**	**> 15000**
General contractor-t	8	4	2	0	2	0
General contractor-st	6	4	0	1	1	0
CM consultant	8	1	3	2	2	0
CM contractor	7	2	2	1	1	1
D-B contractor	6	1	2	3	0	0
Total	35	12	9	7	6	1

There are no two project cases that would have been executed in the same way even along the same procurement route. This indicates both real complexity and difficulties in categorising real projects along the procurement routes. Nevertheless, the comparison of five procurement routes in terms of the surveyed aspects of 35 project cases reveals some merits and demerits of each prevailing route as follows.

5.2.2 Overall project management performance among the project cases

The 35 project cases were not selected randomly (i.e. the respondents selected them). Nevertheless, the cases cover the main procurement routes used in Finland in the early 2000s. The overall project management (PM) performance was measured via nine variables in addition to relationship development variable that were selected by the FinSUKE research team (Kruus and Kiiras 2005) and the author. The research team comprised of one experienced industry practitioner from both the contracting and consulting practices as well as the experienced academics. **The 10 variables** are as follows:

(1) Upper level choice of the procurement route and its effectiveness/consequences as a frame for other variables associated with the project organisation setups
(2) Allocation of risks and responsibilities
(3) Relationship development and management among project parties
(4) Overall client (owner) satisfaction
(5) Overall client (owner) target attainment after the project completion
(6) Client's (owner's) budget attainment within the set targets
(7) Building design management
(8) Project quality assurance, i.e. the finished quality vs. the contract documents
(9) Technical quality of the finished building
(10) On-time project completion attainment.

In Table 15, **the overall PM performance rating** is shown across the variables, their means and the ranges of the rating points among the 35 projects. The respondents were asked to rate the variables on a scale of 5 (very high) – 1 (very low). The overall mean rating is at the level of 3,95. The means varied between 3,60 – 4,21. The rating varied between 3-5 points among the six variables and 2-5 points among the three remaining variables, i.e. budget attainment, design management and responsibility/risk management. On average, the respondents were most satisfied with the selected procurement routes (with the mean of 4.21). Project target attainment, schedule management and client budget attainment were also ranked high. Design management performance was ranked as the lowest area (with the mean of 3.60) due to the late designs and the insufficiency of the (detailed) design documents.

In Table 16, the overall PM performance rating is differentiated **for each of five procurement routes** among the 35 projects. There are no dominant routes. On average, the most effective routes were the D-B contracting (4,09), the CM contracting (4,03) and the CM consulting (3,99) followed by the general contracting with separate trades (3,86) and the traditional general contracting (3,82).

The D-B contracting was rated the most effective route in project target attainment (4,50), design management (4,33) and responsibility/risk distribution (4,00). The CM contracting was rated the most effective route in on-time completion (4,43), quality assurance (4,14) and technical quality (4,00) as well as the least effective one in responsibility/risk allocation (3,57). The CM consulting was rated the most effective procurement route in regard to the route itself (4,38) and overall client satisfaction (4,31) as well as the least effective one in quality assurance (3,75) and technical quality (3,75).

Table 15. Overall PM performance rating (in descending order) among the projects (n = 35). The scale: 5 (very high) – 1 (very low) where each column includes the numbers of the respondents' related perceptions.

Performance variables	Mean	1	2	3	4	5
Procurement route	4,21	-	-	4	19	12
Project target attainment	4,15	-	-	4	22	9
On-time completion	4,10	-	-	6	19	10
Client budget attainment	4,06	-	2	7	13	13
Client's satisfaction	4,00	-	-	8	18	9
Quality	3,88	-	-	8	22	4
Technical quality	3,82	-	-	9	22	3
Responsibility/risk	3,76	-	1	12	15	6
Design management	3,60	-	2	13	17	3

Table 16. Comparison of the overall PM performance rating of the five procurement routes among the projects in terms of means (n = 35)

Performance variables	Total mean	D-B contract-ing	CM con-sulting	General con-tracting -st	CM con-tracting	General con-tracting - t
Procurement route	4,21	4,17	4,38	4,08	4,14	4,13
Project target attainment	4,15	4,50	4,00	4,33	4,00	4,00
On-time completion	4,10	4,08	4,38	3,83	4,43	3,75
Client budget attainment	4,06	4,00	4,13	3,50	4,14	4,38
Overall client's satisfaction	4,00	3,92	4,31	3,83	4,00	3,88
Quality assurance	3,88	4,00	3,75	3,83	4,14	3,75
Technical quality	3,82	3,80	3,75	4,00	4,00	3,63
Responsibilities/risks	3,76	4,00	3,88	3,83	3,57	3,63
Design management	3,60	4,33	3,38	3,50	3,86	3,25
Overall performance	3,95	4,09	3,99	3,86	4,03	3,82

The general contracting with separate trades was rated the most effective route only in technical quality (4.00) and the least effective one as the route itself (4,08), client budget attainment (3,50) and overall client satisfaction (3,83). The traditional general contracting was rated the most effective route only in client budget attainment (4,38) and the least effective one in on-time completion (3,75), quality assurance (3,75), technical quality (3,63) and design management (3,25).

5.2.1 Responsibility distribution and risk allocation management in the project cases

In Figure 26, **the mean rating of the responsibility/risk distribution** varies 3.6 – 4.0 among the five procurement routes. The D-B contracting was rated the most effective route based on the integration of the design management with the other responsibilities and the clear risk distribution among the project parties. In turn, the risk-taking CM contracting was rated the least effective route due to a lack of the adequate checks and the balance when a CM contractor assumes a dual role of a designer and a contractor through the project phases. Many project cases were executed under a non-co-ordinated task approach or under a subcontracting approach with a back-to-back form of risk allocation. In such cases, the specialist contractors were responsible for their detailed mechanical and electrical drawings that were checked by the design team before the incorporation into the overall design. A specialist M&E contractor was responsible for the technical risks. In practice, only a few changes and claims emerged. In addition, some FM services were subcontracted to the specialist service providers.

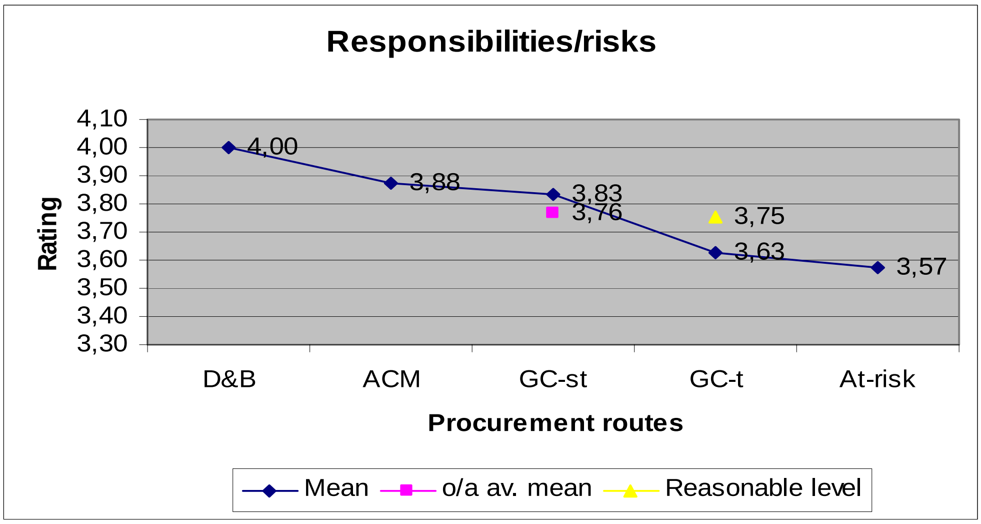


Figure 26. Risk and responsibility distribution rating of the procurement routes among the projects (n = 35)

5.2.2 Relationship development and management among the project cases

The relationship development and management among the project parties are herein addressed in the case of the design phases and the construction phases, respectively. Thereafter, the levels of the relationships are compared between these principal project phases and among the five procurement routes.

In Figure 27, there are no major differences in the effectiveness of the management of **the relationships between the project parties during the design phases**. On average, the relationships between each owner (client) and the designers were rated at the level of 3,97, followed by the relationships among the designers (3,80), those between contractors and subcontractors (3,79), those between each owner (client) and the contractor (3,77) as well as those between consultants and contractors (3,76).

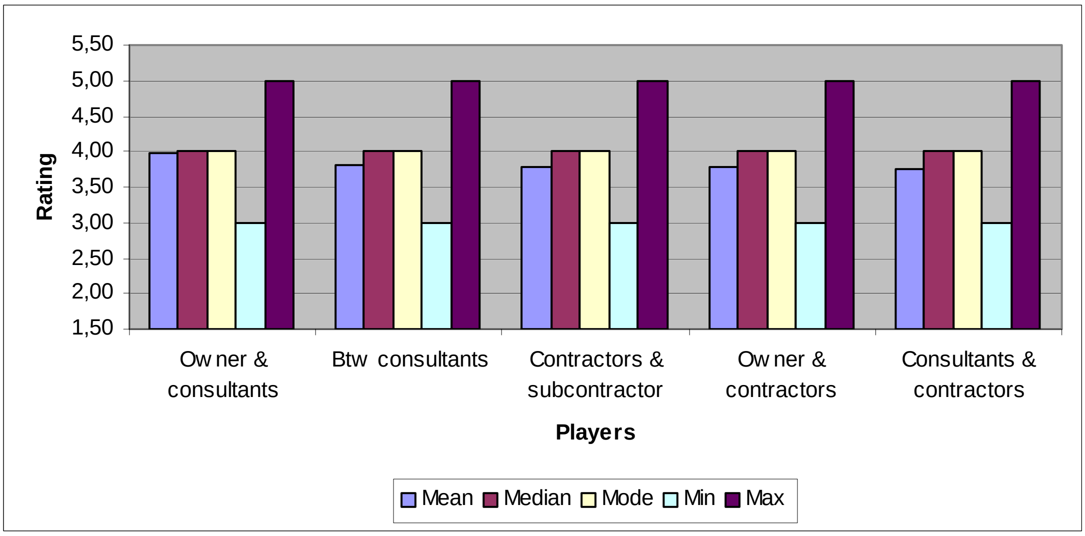


Figure 27. Relationship rating between the parties in the design phases among the projects (n = 35)

In Figure 28, there are no major differences in the effectiveness of the management of **the relationships between the project parties during the construction phases**, perhaps with the exception of some project cases where the relationships between the owner (client) and the designers as well as those between the contractor and subcontractors were rated very low (with the minimum values of 2). On average, the relationships between each owner (client) and the contractors were rated at the best level of nearly four, followed by the relationships among the designers (3.85), those between the contractor and the designers (3.84), those between each client/owner and the designers (3.79) and those between the contractor and the subcontractors (3.72).

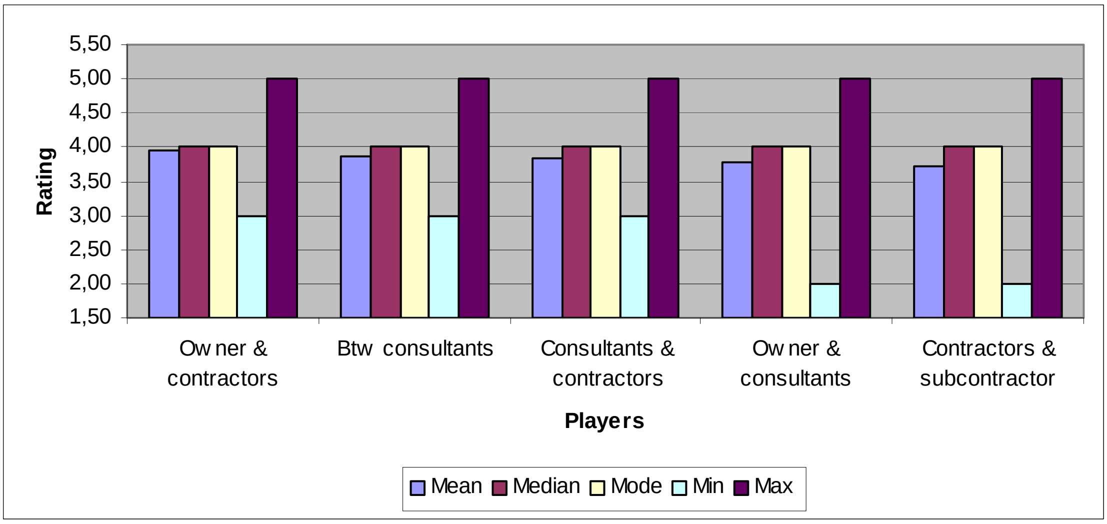


Figure 28. Relationship rating between the project parties in the construction phases among the projects (n = 35)

In Table 17, **the mean relationships ratings are compiled by the five procurement routes and the design and construction phases.** The combined mean rating across all the phases is 3,82 while it varies between 3,88 (relationships between the owners and the contractors) and 3,77 (relationships between the contractors and the subcontractors) among the investigated relationship types.

In turn, the combined mean rating varies between 3,93 (CM consulting) and 3,64 (traditional general contracting) **among the five procurement routes**. The CM consulting and the general contracting with separate trades were rated to have the best relationships between the owners and the contractors (4,00) while the CM contracting was rated the least effective route (3,73). The D-B contracting was rated to have the best relationships among the designers (4,00) while the traditional general contracting was rated the least effective route (3.59). The D-B contracting was also rated to have the best relationships between the contractors and the designers (4,05) while the traditional general contracting was rated the least effective route (3,30). The general contracting with separate trades was rated to have the best relationships between the contractors and the subcontractors (3,90) while the CM consulting was rated the least effective route (3,57). In one illustrative case, the traditional general contracting was used when the relationships between the contractor and the designer turned out to very poor due to the shifting of the responsibilities, i.e. the designer did not produced the design documents on time which caused further delays.

In the design phases, overall, the general contracting with separate trades (4,00) was rated best in managing all the relationships through the design phases, followed by the CM consulting (3,90), the D-B contracting (3,88), the CM contracting (3,74) and the traditional general contracting (3,64). The relationships between the owner and the designers under the CM consulting were rated to peak (at the level of 4,29) while the traditional general contracting was rated the least effective route (3,75). The former trio's relationships were considered free of conflicts. The CM consulting and the general contracting with separate trades were rated best in managing the relationships between the owner and contractors (4,00) while the D-B and CM contracting were rated the least effective routes (3,60). The D-B contracting and the general contracting with separate trades were rated best in managing the relationships among the designers (4,00) and between the contractor and the designers (4,00) while the traditional general contracting was rated the least effective route in regard to these relationships (3,57 and 3,20).

However, there were **some opposing views** among the respondents. The proponents of the D-B contracting perceived that a better understanding is achieved when the designers are working on a competitive basis for the same project goal. In turn, the most positive GC-st views were based on the joint obligation with the owner that brings about the most workable solutions. In addition, the two general contracting routes (4,00) were rated best in managing the relationships between the contractor and the subcontractors while the CM consulting was rated the least effective route (3,50). This may be due to the fact that many general contractors choose the subcontractors from their long-term pools on a repeated basis.

In the construction phases, overall, the CM consulting (3,97) was rated best in managing all the relationships during the construction phases, followed by the D-B contracting (3,94), the CM contracting (3,85), the general contracting with separate trades (3,67) and the traditional general contracting (3,65).

Table 17. Comparison of the mean relationship ratings of the procurement routes in the design and construction phases among the projects (n = 35)

Procurement route	Owner and designers	Owner and contractors	Among designers	Contractor and designers	Contractors and sub-contractors	Mean
Design Phase						
CM consulting	4,29	4,00	3,83	3,86	3,50	3,90
GC-st	4,00	4,00	4,00	4,00	4,00	4,00
D-B	4,00	3,60	4,00	4,00	3,80	3,88
CM contract-ing	3,83	3,60	3,75	3,75	3,75	3,74
GC-t	3,75	3,67	3,57	3,20	4,00	3,64
Mean	3,97	3,77	3,83	3,76	3,81	3,83
Construction phase						
CM consulting	3,93	4,00	4,14	4,14	3,64	3,97
GC-st	3,60	4,00	3,33	3,60	3,80	3,67
D-B	3,60	4,20	4,00	4,10	3,80	3,94
CM contract-ing	4,00	3,86	3,86	3,83	3,71	3,85
GC-t	3,71	3,86	3,60	3,40	3,67	3,65
Mean	3,77	3,98	3,79	3,81	3,72	3,82
Design and Construction phases						
CM consulting	4,11	4,00	3,99	4,00	3,57	3,93
GC-st	3,80	4,00	3,67	3,80	3,90	3,83
D-B	3,80	3,90	4,00	4,05	3,80	3,91
CM contract-ing	3,92	3,73	3,81	3,79	3,73	3,79
GC-t	3,73	3,77	3,59	3,30	3,84	3,64
Combined Mean	3,87	3,88	3,81	3,79	3,77	3,82

The relationships among the designers and between the contractor and the designers were rated to peak (at the level of 4,14) under the CM consulting routes while the general contracting separate trades (3,33) was rated the least effective route in managing the relationships among the designers and the traditional general contracting (3,40) was rated the least effective route in managing the relationships between the contractor and the designers. The CM contracting was rated best in managing the relationships between the owner and the designers (4,0) while the general with separate trades and the D-B contracting were rated the least effective routes (3,60). The D-B contracting was rated best in managing the relationships between the owner and the contractors (4,20) while the CM contracting and the traditional general contracting were rated the least effective routes (3,86). The general contracting with separate trades and the D-B contracting were both rated best in managing the relationships between the contractors and the subcontractors (3,80 while the CM consulting was rated the least effective route (3,64).

5.2.3 Overall client satisfaction management among the project cases

In Figure 29, the overall mean of **the client/owner satisfaction** is shown to be rated at the high level of 4,0. The satisfaction varied 3,8-4,3 among the five procurement routes. The CM consulting (4,31) was rated best in achieving high client satisfaction while the general contracting with separate trades (3,83) was rated the least effective route in this respect. This ranking seems to be consistent with the overall rating of the effectiveness of the five contracting/procurement methods (see the left part in Figure 29).

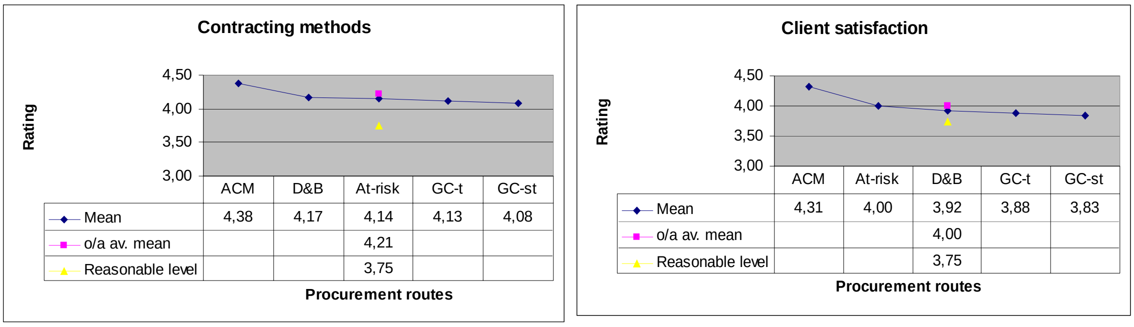


Figure 29. Contracting methods and client satisfaction rating of the procurement routes among the projects (n = 35)

In Figure 30, the overall mean of **the client's/owner's project target attainment** is shown to be rated at the level of 4,2. The target attainment varied 4,0-4,5 among the five procurement routes. The D-B contracting was rated best (4,5) followed by the general contracting with separate trades (4,3). The single point of the D-B contractor's performance responsibility as well as the D-B contractor's and the GC-st contractor's inputs in value management/engineering were mentioned to be key factors behind the high degree of project target attainment.

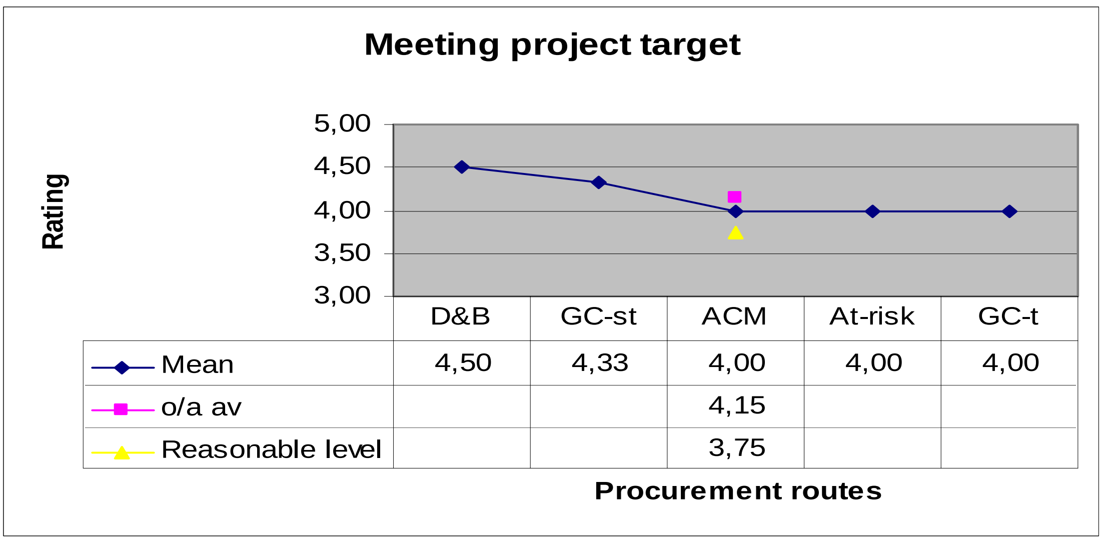
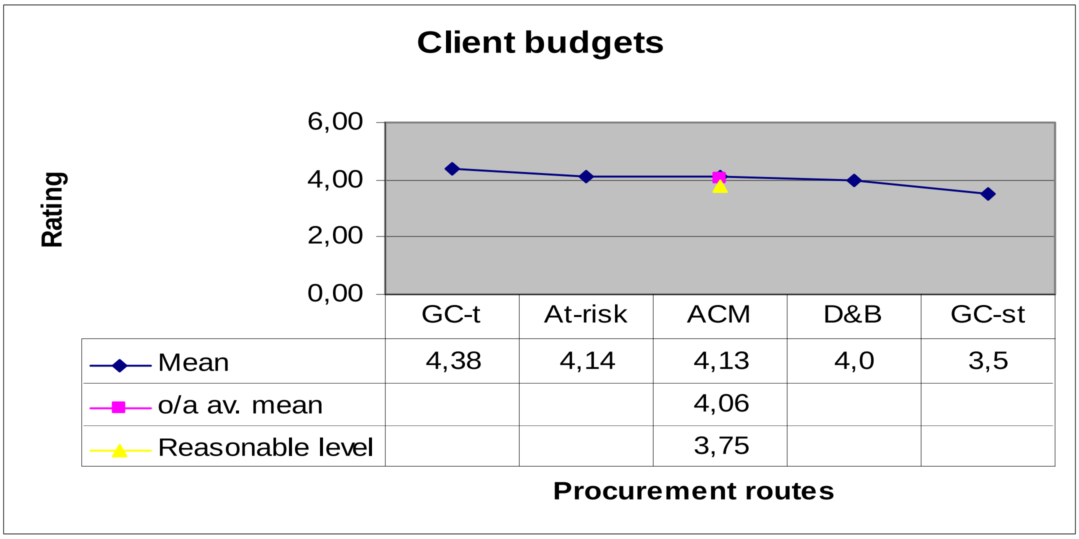


Figure 30. Project target attainment rating of the procurement routes among the projects (n = 35)

In Figure 31, the overall mean of **the client's/owner's budget attainment** is shown to be rated at the high level of 4,1. The budget attainment varied 3,5-4,4 among the five procurement routes. The traditional general contracting (GC-t) was rated best (4,4) primarily due to the completeness of the documents before the actual construction works begin.



	GC-t	At-risk	ACM	D&B	GC-st
Mean	4,38	4,14	4,13	4,0	3,5
o/a av. mean			4,06		
Reasonable level			3,75		

Figure 31. Client's/owner's budget rating of the procurement routes among the projects (n = 35)

5.2.4 Building design and technical quality management among the project cases

In Figure 32, the overall mean of **the building design management** is shown to be rated at the fairly low level of 3,6. The level of the design management varied 3,3-4,3 among the five procurement routes. The poor design management was witnessed in the case of the traditional general contracting (3,3) and the CM consulting (3,4) below the overall mean and the reasonable level of performance 3,75. This was due to the fact that the contractor was not involved in the design process, the overall design resulted in many design changes, the design documents were not ready on time and a lack of the responsibilities/penalties in the case of design mismanagement. In four project cases, the specialist contractors or the subcontractors were acting in the capacity of **the multiple prime contractors** engaged in the design and construction of their section of the contracts (e.g. the structural shell, the HVAC systems). These contractors were involved early to work with the design team so that their system, building product or specialised construction work could be fully integrated with the main works. The design team provided them with the information on the functionality, the specifications and the usage of the building. The dual tendering involved the subcontractors to compete on the price, the schedule and the quality as well as on the life-cycle value management as part of the FM services and the renewal. In these cases, the main contractor coordinated the construction works and the design team provided PM and administration services.

In Figure 33, the overall mean of **the project quality assurance** is shown to be rated at the fairly low level of 3,9. The level varied 3,8-4,1 among the five procurement routes. The CM contracting was rated best (4,1) followed by the D-B contracting (4,0) due to the both contractor's involvement in the preconstruction phase and the value engineering management.

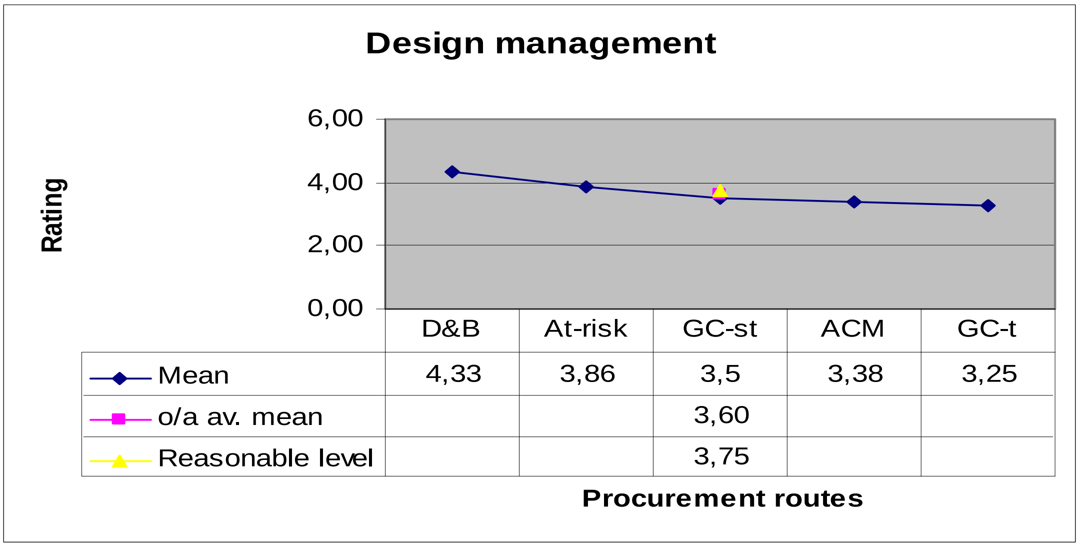


Figure 32. Design management rating of the procurement routes among the projects (n = 35)

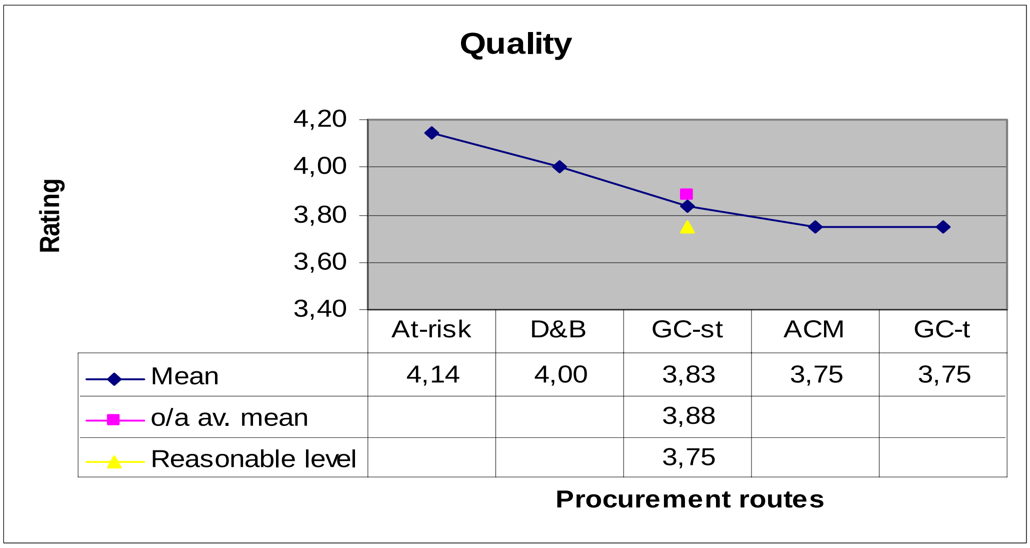


Figure 33. Project quality rating of the procurement routes among the projects (n = 35)

In Figure 34, the overall mean of **the technical quality level** is shown to be rated at the fairly high level of 3,8. The level varied 3,6-4,0 among the routes. The general contracting with separate trades and the CM contracting were rated best (4,0) in managing the technical quality. The former trade contractors participated already in the design phase (some of them even carried out the design work).

5.2.5 Schedule management among the project cases

In Figure 35, the overall mean of **the project schedule management** is shown to be rated at the high level of 4,1. The level varied 3,8-4,4 among the five procurement routes.

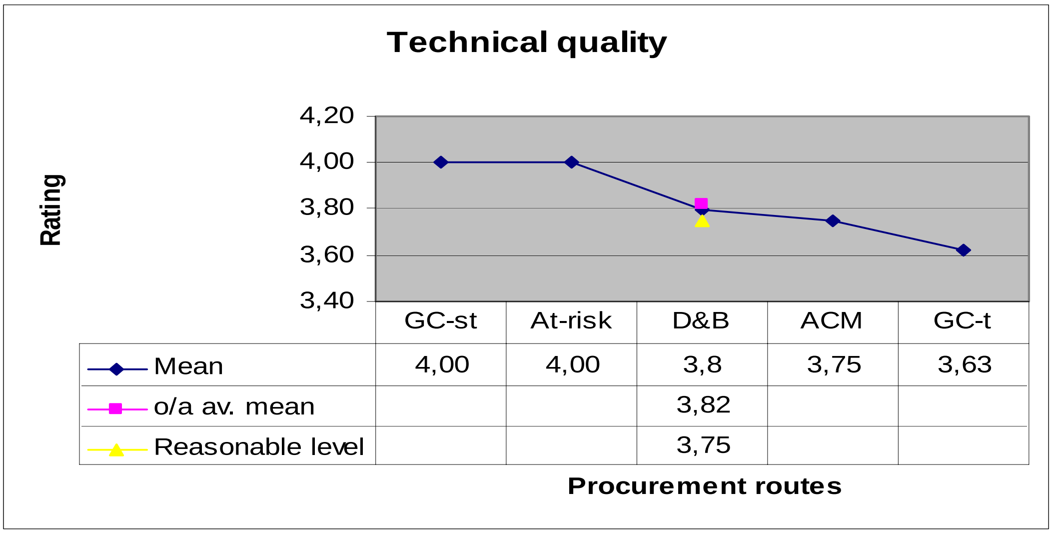


Figure 34. Technical quality rating of the procurement routes among the projects (n = 35)

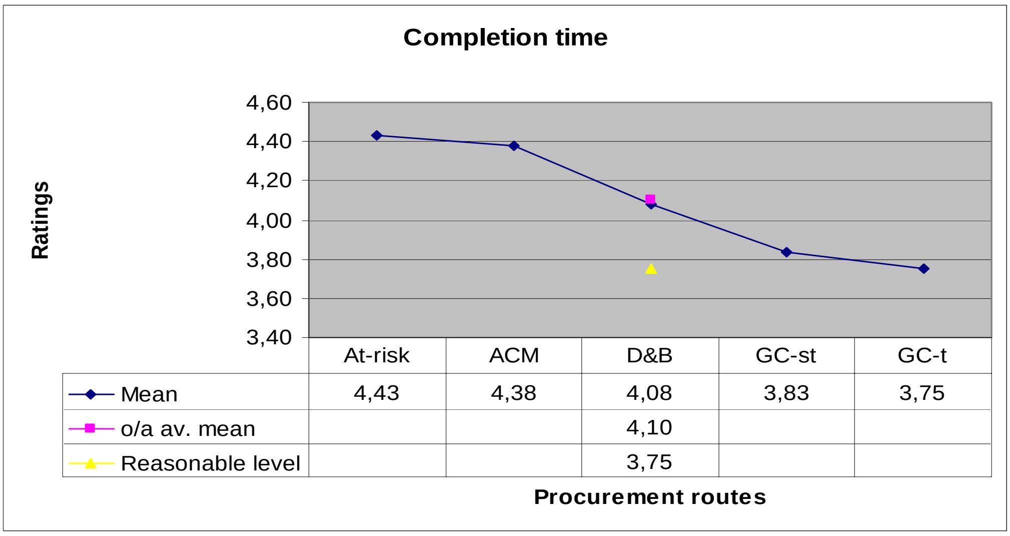


Figure 35. Completion time rating of the procurement routes among the project cases (n = 35)

The risk-carrying CM contracting was rated best (4,4) because of the involvement of the CM contractor in the preconstruction and construction phases adding more value in the constructability, the early construction decision-making and the trust among the other project parties.

In Table 18, **the three basic types of the scheduling** among the 35 projects are shown. The further analysis revealed many variations or hybrids of these basic types. The factors underlying the determination of the schedule type involve the amount of available information, the client's readiness to build, the client's relationship with the contractor(s) and trade contractors and the trust between the major parties.

Table 18. Three basic types of the scheduling by phase among the projects (n = 35)

Type	**Programming/ schematic design**	**Working drawings**	**Tendering/ procurement**	**Construction works**
Type 1 Tradit-ional (n1= 21)	Programming phase is completed before the schematic design begins.	Working drawings are commenced at the tail end of the schematic design.	Tendering/ procurement phase is commenced after the completion of the working drawings	Construction work begins after the completion of the tendering/procurement phase.
Type 2 Concur-rent (n2= 6)	Programming and schematic phases are commenced simultaneously.	Schematic design is completed before the commencement of the working drawings.	Tendering/ procurement phase is com-menced before the completion of the working drawings.	Construction work is commenced concurrently with the tendering/procurement phase after the completion of the working drawings.
Type 3 Fast-track (n3= 8)	Schematic design is commenced in the middle of the pro-gramming phase.	Working drawings are commenced in the middle of the schematic design.	Tendering/ procurement phase is com-menced before the completion of the working drawings.	Construction work is commenced concurrently with the tendering/procurement phase before the com-pletion of the working drawings.

5.2.8 Results supporting the prevailing procurement routes vis-à-vis the STO route

In Table 19, **the correspondence between the STO route and the five prevalent procurement routes** is compiled by using the same performance variables that were used in the project case questionnaires. The marked connections (X) show that all the attributes of the STO route can be found in one or some other procurement routes. For example, in the area of design management the STO route is similar to the general contracting with separate trades (GC-st) route in terms of task or trade contractors participating in actual design via competition and task design management that allows innovations and leads fragmented processes.

The STO belongs to integrated and fragmented spectrum with the responsibilities in design, construction and facility maintenance, and with the relationships between the owner and the STO management team. For example, the general contracting with separate trades is a fragmented process with the separate trade contractor involved in design and construction.

In the case of the five performance variables, the five prevailing procurement routes are considered either high or low on performance based on the overall performance level in Table 16 and in line with **the reasonable PM performance leve**l, i.e. the performance over 3,75 is at a high level and the one less than 3,75 is at a low level. This level of 3,75 corresponds to 75 % of the maximum rate (5).

Table 19. STO route's correspondence to the five procurement routes

PM performance variables	**General con-tracting -st**	**General con-tracting - t**	**CM con-sulting**	**CM con-tracting**	**D-B con-tracting**	**STO route**
Procurement route/PM						
¤ fragmented	X	X	X	X		
¤ integrated					X	
¤ integrated+fragmented						X
Responsibility/risk allocation						
¤ design	(X)				X	X
¤ construction	X	X	X	X	X	X
¤ maintenance						X
Relationships management						
¤ main contractor	X	X		X	X	
¤ subcontractors	(X)	X		X		
¤ trade contractors			X			
¤ task specialists						X
¤ project managers	X	X	X	X	X	X
¤ owner/client	X	X	X	X	X	X
Overall client satisfaction						
¤ high	X	X	X	X	X	X
¤ low						
Client target attainment						
¤ high	X	X	X	X	X	X
¤ low						
Client budget attainment						
¤ high		X	X	X	X	X
¤ low	X					
Design management						
¤ competition	(X)				X	X
¤ innovation	(X)				X	X
¤ management	(X)	X	X	X	X	X
¤ specialisation	(X)					X
¤ fragmented	(X)	X	X	X		X
¤ integrated					X	
Quality assurance						
¤ high	X	X	X	X	X	X
¤ low						
Technical quality management						
¤ high	X		X	X	X	X
¤ low		X				
Project schedule management						
¤ traditional	X	X	X	X	X	
¤ concurrent	X		X	X		X
¤ fast-track	X		X	X		X

In Figure 36, **the variance of the PM performance among the 35 project cases** is compiled in terms of nine variables across the five prevailing procurement routes. Overall, the variance is 0,27 between the highest mean of the D-B contracting (4,09) and the lowest mean of the traditional general contracting (3,82). The medium means belong to the CM contracting (4,03), the CM consulting (3,99) and the general contracting with separate trades (3,86). The nine PM performance areas are herein listed in the order of the size of the variance among the mean ratings as follows:

- Building design management: the variance is 1,08 between the highest value of the D-B contracting (4,33) and the lowest mean of the traditional general contracting (3,25).
- Client budget attainment: the variance is 0,88 between the highest mean of the the traditional general contracting (4,38) and the lowest mean of the general contracting with separate trades (3,50).
- On-time completion: the variance is 0,68 between the highest mean of the CM contracting (4,43) and the lowest mean of the traditional general contracting (3,75).
- Project target attainment: the variance is 0,50 between the highest mean of the D-B contracting (4,50) and the three lowest means of the CM consulting, the CM contracting and the traditional general contracting (4,00).
- Procurement route/PM as a whole: the variance is 0,30 between the highest mean of the CM consulting route (4,38) and the lowest mean of the traditional general contracting (4,08).
- Overall client satisfaction: the variance is 0,43 between the highest mean of the CM consulting (4,31) and the lowest mean of the traditional general contracting (3,88).
- Performance risks and project responsibilities: the variance is 0,43 between the highest mean of the D-B contracting (4,00) and the lowest mean of the CM contracting (3,57).
- Project quality assurance: the variance is 0,39 between the highest mean of the CM contracting (4,14) and the two lowest means of the CM consulting and the traditional general contracting (3,75).
- Technical project quality: the variance is 0,25 between the two highest means of the general contracting with separate trades and the CM contracting (4,00) and the lowest mean of the CM consulting (3,75).

The summary of the project case survey reveals the valid point that **each of five prevailing procurement routes has its strengths and weaknesses** across the nine areas of the project management as measured through the nine performance variables. This supports the previously stated argument that there is no single procurement route that suits best to all kinds of building projects. In the overall PM performance, the D-B contracting was rated best followed by the CM contracting, the general contracting with separate trades (GC-st), the CM consulting and the traditional general contracting (GC-t). Nevertheless, it seems that **the five prevailing procurement routes differ** in their PM performance as follows:

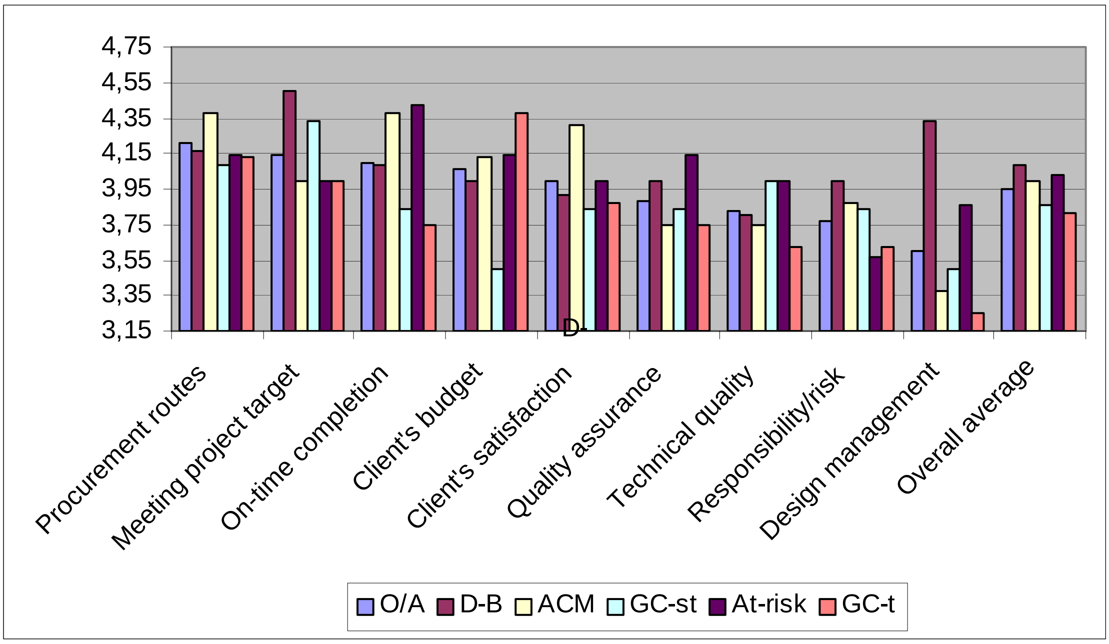


Figure 36. Comparison of the 9-variable PM performance rating of the procurement routes among the projects (n = 35)

- The D-B contracting was evaluated to be best in the design management, the balanced responsibility/risk distribution and the project target attainment.
- The CM consulting was evaluated to be best in achieving the high client satisfaction.
- The general contracting with separate trades (GC-st) was evaluated to be best in managing the high technical quality.
- The risk-carrying CM contracting was evaluated to be best in the tight project schedule management, the high project quality assurance and in the high technical quality (together with GC-st).
- The traditional general contracting (GC-t) was evaluated to be best in attaining the client budget.

In Table 20, **the results supporting the five prevailing procurement routes** are compiled. The PM performance along the nine variables (areas) under the five prevailing procurement routes was rated in most of 35 project cases above the reasonable level of 3,75 (as summarised in Figure 36). Herein, only the best PM performance levels with the rating of 4,00 – 4,43 are shown across the nine variables (areas) in the left column of Table 20. Based on the corresponding high values of the nine variables (shown in Table 19), **a high PM performance potential of the STO route** is exposed in the right column of Table 20 as a set of the possible combinations of the best measured features of the five prevailing procurement routes. For instance, the single point of performance responsibility of each STO task corresponds to the well-balanced responsibilities/risks in the case of the D-B contracting (4,0).

Table 20. Results of the project cases survey supporting the prevailing procurement routes and the corresponding PM areas of the STO route

High values of variables	Results supporting the prevailing procurement routes	Corresponding support to the PM areas of the STO route
High over-all PM/route performance management	Target attainment, on-time comple-tion, budget attainment, quality control and management, technical quality attainment, the proper dis-tribution of responsibilities/risks and better design management	Timely delivery of the integration, low cost opportunities, the low level of conflicting interests, the elimination of the non-value adding costs of frag-mentation and the advantages of fast tracking based on specialisation and task uncertainty
Balanced responsib-ilities/risks	Single point of D-B (4,0) perform-ance responsibility and risk on non-performance	Single task/performance responsibility over the project life-cycle with integrated management approach
Effective relationship management	Direct contract with an owner as in CM consulting, single point of responsibility as in D-B and GC-t and multiple points in a construct-ion phase as in CM consulting and GC-st	Direct contracts between an owner and other project parties. Single point of task responsibility in a preconstruction phase and multiple points in a construction phase. Each STO assumes a prime role on an equal basis.
High over-all client satisfaction	In CM consulting (4,31), the direct contractual relationships between an owner and trade contractors as well as the reduction of cost (a layer of profit)	Direct contractual relationships, the re-duction of cost (a layer of profit, bid shopping), better technical quality through competition and its assurance within budget
High client target attainment	In D-B (4,50), clarity in defining an owner's requirement through the project performance specifi-cations	Project performance based on the technical specifications and an STO experts' advice on user's requirements, constructability, materials usage, usability, and maintainability
High client budget attainment	In GC-t (4,38), wider contingency amount that covers design, and the completion of the working documents before construction works begins	Extensive solution-based involvement results in minimum changes and ascertained task costs, and adds value in life-cycle costing. The use of many alternative incentives (e.g. with GMP).
Effective building design management	In D-B (4,33), single point of design/construction responsibility and performance risk	Integrated project development, early design involvement that eliminates uncertainty in a construction phase, and single point of design/construction responsibility and risks for each task
Effective project quality assurance	In CM contracting (4,14), a con-tractor's involvement in a pre-construction phase and value engineering management	Value engineering and life-cycle management via competition
Effective technical quality management	In GC-st and CM contracting (4,00), specialist involvement via competition in design and construction works	Specialisation and improvement in technical qualities due to better understanding of tasks: competition also on design, maintainability, life-cycle costing and vale assessments
Effective project schedule management	In CM contracting (4,43), the integrative involvement of a CM contractor	Concurrent detailed design and construction through fast-track and open building concepts ensuring high constructability in a construction phase

In Table 21, **the four low PM performance areas under the five prevailing procurement routes** are compiled. In other words, the mean rating was below the reasonable level of 3,75 in the areas of client budget attainment, technical quality management, responsibility/risk allocation and building design management in the case of four prevailing procurement routes, respectively, as shown in the left column of Table 21. The PM problems with the severe negative consequences included the unclear definition of the responsibilities (as in GC-st), the non-involvement of the contractors in design (as in GC-t) and the clash of the CM contractor's interests when he acted both as a designer and a contractor. In turn, **the adoption of the STO route** is validated in the right column of Table 21 in terms of the key ways to avoid similar low performance and problems in future new building projects.

Table 21. Measured low PM performance of the prevailing procurement routes among the projects and the adoption of the STO route

Variables	Measured low PM performance (< the reasonable level of 3,75)	Adoption of the STO route and the key ways to avoid low performance
Client budget attainment	GC-st was rated low (3,50) due to the unclear responsibilities resulted in many management problems between the main contractor and the separate trade contractor.	Clear task/work specifications early in a preconstruction phase eliminate/ reduce risks associated with changes and uncertainty. Clear risks and responsibilities exclude budget-influencing conflicts of interest between project parties.
Technical quality	GC-t was rated low (3,63) due to the main contractor's non-involvement in the design and the shifting of the blame between the designers.	Early involvement in a design phase and the preparation of task-specific working and detailed drawings. The clear task-specific responsibilities eliminate blame shifting between project parties.
Responsibility/ risk allocation	CM contracting was rated low (3,57) due to the clash of the CM contractor's dual interests as the designer and the contractor. GC-t was rated low (3,63) due to the uncertainty associated with the design and construction works (e.g. a lack of value engineering and management).	Clearly defined responsibilities in all phases through the separation of power which excludes conflicts of interest between an owner, designers, STO management team and STOs. Technical designs, material and construction methods are ascertained before construction is commenced.
Building design management	GC-t (3,25), CM consulting (3,38) and GC-st (3,50) were rated low due to a lack of involvement in design process (except the separate trade contractors), insufficiency of design and a lack of value engineering and management.	Involvement in task-specific technical and working drawing design process based on design and value engineering competition. Integrated design management e.g. via a web-based information system.

It is again pointed out that the high PM performance potential of the suggested STO route is based on the combination of the high building quality attributes of integration and the low-cost attributes of fragmentation. Based on the results of the project cases survey, this potential of the STO route is validated further across the 10 areas of PM performance in the case of large buildings as follows.

The overall project management of the 35 project cases under each of five prevailing procurement routes suffered one or several in-built weaknesses. In turn, **the STO route** ensures an integration-based, on-time project completion and the other advantages of fast-tracking, low-cost opportunities, the low level of conflicting interests and the elimination of fragmentation-based, non-value adding costs. At the upper level, the STO route relies on the integration through a STO management team. At the lower level, the fragmentation is exploited among STOs who can specialise themselves and innovate through task uncertainty. Overall, it is likely that the adoption of the STO route results in the more effective time, cost and quality management of building projects.

In the area of **balanced responsibility/risk management among project parties**, many project cases were executed under an non-co-ordinated task approach or a subcontracting approach with a back-to-back form of risk allocation. The separate trade contractors were responsible for their detailed drawings, technical quality and risks. This encouraged them to innovate and to raise the quality standards. For example, one specialist contractor suggested the adoption of a self-supporting glass wall that reduced the external wall area markedly. Similarly, **the STO route** exploits the coordinated specialist contracting as part of the integrated management approach. Each STO has a single-task performance responsibility over the project life-cycle (including the optional FM services). In principle, project responsibilities are defined well and none of the parties is assuming a dual role that might deter checks and balances. Each project risk is allocated to the party who is assumed to be best in handling the risk in question.

In the area of **project party relationship management**, the relationships between the owner (client) and the designers as well as between the owner and the contractors were managed best in the design phases under the CM consulting. In turn, the relationships between the owner and the contractors were managed best in the construction phases under the D-B contracting. Multiple direct contracts with an owner seem to be free of conflicts and, thus, to be beneficial to the entire building process. In turn, the two GC contracting routes were ranked best in managing the relationships between the contractor and the subcontractors. Similarly, **the STO route** is sharing these particular effective attributes of the CM consulting, the D-B contracting and the GC contracting. The STO route allows direct contracts between an owner and other project parties. It extends the participation of STOs through all project phases. Each STO is selected based on their sub-solution performance and price competitiveness. The integrated management system ensures the workable solution as a whole.

In the areas of **overall client satisfaction and client target attainment,** the CM consulting was ranked best based on the direct contractual relationships between the owner (client) and the trade contractors, in part on the cost reduction. Similarly, **the STO route** allows direct contracts with an owner and exploits the fragmented network of STOs. The difference, however, is the involvement of STOs in design management, which subsequently supports a balanced responsibility/risk distribution. Thus, the STO route combines the merits of the CM consulting and the D-B contracting as well as eliminates some of their weaknesses.

In the area of **client budget attainment,** the traditional GC was rated best in attaining the client's budget because the working documents are completed before the construction works begin. Similarly, **the STO route** utilises many incentives in meeting the budget such as a GMP plus incentive and bonuses. Although STOs do not act as designers in design phases, their early and extensive solution-based involvement results in minimum changes and ascertained task costs as well as adds value in the life-cycle costing of buildings.

In the area of **building design management under the GC-st route**, many separate trade contractors and subcontractors acted as the multiple prime contractors engaged in the design and construction of their section of the contracts. Some main contractors coordinated the construction works and the design team provided PM and administration services. This is more evident in the D-B route due to a single point of responsibility/risk in both building design and construction. There were no major strains between the stakeholders in communication, cooperation and coordination throughout all the project phases. Similarly, **the STO route** allows a building design team provide an overall design including specifications. At the early phases of projects, STOs eliminate uncertainty, i.e. they produce detailed engineering designs that are used in contracting/procurement and construction.

In the area of **project quality assurance,** the CM contracting and the D-B contracting were rated best due to the contractor's involvement in the preconstruction phase and the value engineering management. Similarly, **the STO route** is a process that encourages value engineering and life-cycle management via competition.

In the area of **technical quality management,** the GC with separate trade contractors contributed markedly to the design phases (some of these trade contractors even carried out the design work). Similarly, **the STO route** enables the involvement of separate STOs in design and construction especially in the case of HVAC systems and related FM services. Overall, the division of a project into its major tasks enhances specialisation and improvement in technical qualities.

In the area of **project schedule management,** the CM contracting was rated best based on the integrative involvement of the CM contractor. Similarly, **the STO route** allows concurrent detailed design and construction through the fast-tracking and open building concepts. A modular design approach solves problems associated with on-time building design processes. Narrow design scopes are centred around tasks. The expertise of STOs and the consideration of constructability factors have positive effects in construction phases.

5.3 Project Case Study Examples

The analogical validation is based on finding the analogies between the positive outcomes of four case study examples and the PM principles of the STO route. Example 1 focuses on the structural frame and the glass façade of three office blocks. It was compiled with one of the primary researchers of the FinSUKE project. Three other examples are abstracted from two published project case study reports, Salmikivi (2005) and Pernu (2000), and complemented with the informal discussions with the authors and some of the project parties. Example 2 focuses on the structural frame of the multi-storey apartment block. Example 3 focuses on the HVAC systems of the science park. Example 4 focuses on the structural frame and HVAC systems of the laboratory building.

5.3.1 Case study example 1 – Three office blocks

This case example consisted initially of two office blocks (with an option for a third block). The owner is the insurance company that developed the office blocks under a separate limited liability company (subsidiary). The owner's team was comprised of the risk-carrying CM contractor and the designers. The CM contractor was selected early to allow his participation in the PM over the preconstruction phase. He acted as the owner's main representative and negotiated the direct contracts between the owner and the specialty contractors. The leaseholder and user is a multinational IT services company who was also involved early in the conceptual and overall design.

The project was divided into 11 main tasks: sub-structural works, a structural frame, a glass facade, cladding, roofing, in-fill, HVAC systems, electricity, plumbing, external works and minor specialist works (e.g. art, security and surveillance). The procurement procedure involved the design team that produced the overall detailed design. Bidders were requested to calculate their estimates based on this design. In addition, the design team provided the general information for the interested bidders to enable the preparation of both the alternative designs and the related estimates.

Office building design

When the users' requirements were first fully established, the design team was commissioned to produce the overall building design. The concept design went through a series of the adjustments to accommodate the users' solutions. The conceptual/detailed designs with the technical, performance and material specifications were sent to potential bidders, i.e. specialty contractors.

Bidding procedure

Within the invitation-to-bid documents, the owner provided the general information about the blocks, e.g. the floor areas and the building volumes. The first block is 7,283 square meters and 49 000 cubic meters. The second block is 7,400 square meters and 48 400 cubic meters with the 149 square meters for the sauna section. The documents included the concept design followed by the detailed design (after three weeks) in order to enable the two-way bidding: the bid based on the detailed design and the alternative one based on the specialty contractor's own solution. The specialty contractors could utilise their expertise by adding, subtracting and/or adjusting the original detailed design or by offering a new concept. The additional information was submitted for such individual solutions. For instance, the owner provided the items in the preliminaries (site services) that might have caused consequences in costs if unmentioned (e.g. a main crane and water and electricity for works). Each specialty contractor submitted his technical design/working drawings to the design team, which pre-checked them and sent later the winners' documents to the town planning authority for the approvals. All the identified grey areas were captured at the joint meeting with the bidders.

The owners' documents were meritorious as they permitted the specialty contractors to compete on an equal basis. However, the owner had the right to divide each main task into its elements in order to procure them from the separate suppliers and to involve more specialists for the specific installations for the purpose of minimizing the costs.

The initial construction period given was May-December 2003 for the structural frame. The specialty contractors were also asked to submit their project schedules. The conditions of the contract also stipulated that the selected specialty contractor is liable to liquidated and ascertained damages. A retention fee of 2 % was set for the 24-month defect liability period since the date when the building was handed over. The performance bond was specified at the level of 10 %. The last payment (10 % of the price) was to be paid after the owner had verified the compliance of the specialty contractor's performance with the contract. The specialty contractors were selected based on their previous performance and the prequalification exercise. Each specialty contractor was asked to specify the design fee (if his design was to be used) and, in cumulative terms, the price of the materials to be delivered to the site, the cost of the installation and the cost of the additional crane services.

Structural frame

The owner's invitation-to-bid documents included the structural specifications including those for the beams, the columns, the floors, the spacing of the trusses and the load-bearing structure of each frame. The minimum requirements included the heights of the ground floor (4,5 m), the basement and the other floors (3,6 m), the heating and ventilation room with the free space (4,6 m), the special spaces in the basement, especially the maintenance route (5,0 m). The annexes consisted of the architectural and the structural drawings plus the responsibility distribution chart. Five structural frame contractors submitted their bids that followed the original invitation with some changes only. Many other contractors bid on both the original steel frame and the alternative concrete-based frame. During the evaluation process, the submitted drawings plus their implications on the cost, the schedule, the quality and the life-cycle costing were thoroughly examined. The schedule of the winner was incorporated into the overall design to ensure the programme compatibility and the master schedule. The selection criteria of the owner were based on the fixed price bid, the general quality level, the compatibility with the other project tasks (design and construction) and the life-cycle management. Three major negotiations on the prices took place before the contract was signed. The winner also submitted the alternative scheme.

Glass facade

The owner's invitation-to-bid documents included the scope of the glass façade, including the wall, the doors, the windows, the complete aluminium frame and the accessories as well as the sun and rain screen. The extra features like the glass wall for the main entrance and the hall were included in Block 2. Contractors were asked to bid for each of the elements on a functional block-by-block basis. During the procedure, the design team twice made some changes that were communicated to the contractors. The costs of the bid included the design (optional), the manufacturing, the materials, the delivery and the installation with the related equipment (except the major crane). No overhead was allowed for the specific items of the material or the labour.

The winner submitted the bid based only on the owner's detailed design. The advantage of this approach was that the competition was based on the design, the materials and the life-cycle management. One of the winner's merits involved the alternative glass type that suited best the environmental requirements. The sound, solar and light penetration qualities of the glass took into account the location near the highway. The fixed price contract was agreed upon. The winner's work schedule was adjusted and incorporated into the master schedule.

5.3.2 Case study example 2 – Multi-storey apartment block

Example 2 is based on the multi-storey apartment block as the pilot project studied by Pernu (2000). The description is focused on the bidding documents and procedure of the structural frame as follows.

Bidding documentation

The conceptual drawings for the multi-storey apartment block were more detailed than in the case of the traditional competitive bidding procedure in Finland. The frame was not specified in detail. The slab span limit was stated to be 6-7 meters. This was to allow the sufficient space for the steel columns in the architect's design. The details from the city plan were also included. For instance, the facade should be brickwork. In the balcony design, the appearance was described to allow the use of optional production methods. The performance specifications outlined the required quality level and materials without the quantities.

In Table 22, the owner's invitation-to-bid documents are shown to include (besides the conceptual architectural design on a scale of 1:100) the performance specifications on the architectural, structural, mechanical and electrical services. During the bidding period, the architect continued to produce the additional design information that was sent to all the competing contractors.

Table 22. Invitation-to-bid documentation of the owner in Example 2

Architectural design
Typical fitting schemes in dwellings
Window and door schemes
Details of balcony, eaves and stairs
Site surface structures and plants
Structural engineering
Roof structures
Brickwork with details
Rainwater sewerage
Engineer's performance specification (sections of structures and details)

In Table 23, the documents to be submitted by the competing contractors are compiled to allow the evaluation, i.e. the completed performance specifications for all the four areas with the further details in the structural engineering and the typical schedules for the mechanical and electrical works.

Bidding procedure

It was decided beforehand that a winner would be determined based on the price and the design/solution documents. Four contractors submitted their distinct solutions based on the steel, composite slab, in-situ concrete and prefabricated concrete frames. This new procedure resulted in the healthy competition and the innovative design with the possible minimum cost. Each submitted solution was evaluated in terms of the cost, the structural loads, the functionality, the aesthetics and the schedule. The difference between the highest and lowest bid price was only 7 %.

Table 23. Bid documentation for contractors in Example 2

Architectural design
Completed performance specification
Structural engineering
Foundation plans
Load bearing structures on the typical floor and section
Structures
- details of connections to load-bearing structures and to the roof
Completed performance specification
Mechanical engineering
Completed performance specification for the mechanical engineering
Mechanical works schedules for the typical floor
Electrical engineering
Completed performance specification for the electrical engineering
Necessary electrical works schedules for the typical floor

None of the solutions was superior or non-eligible. The winner was chosen on the basis of the fixed price bid, the level of the general quality and the solution for the life-cycle costs. There was no need to apply more subjective criteria because the owner had pre-accepted those frame alternatives that were both eligible and equivalent vis-à-vis quality and life-cycle costs. In addition, the prequalification was conducted to ascertain the contractors' capabilities.

5.3.3 Case study example 3 – Science Park

Example 3 involves the headquarters building of the science park in Viikki in the Helsinki metropolitan area. It was the pilot project for the experimental procurement of the HVAC systems (Pernu 2000 and Salmikivi 2005). The aim of the original study was to develop the new procurement method and tendering documents for the GC-st contracting where, exceptionally, the owner (client) chooses the subcontractors (by separate trades). Hence, subcontractors were encouraged to innovate solutions for the mechanical systems with the advantageous life-cycle costs and the operational responsibility for the five-year period. The architect was commissioned based on the building design competition. The selected design solution was the duplex facade with the outer glass shell. The PM team consisted of the professional representatives of the user, i.e. the University of Helsinki.

As part of this new open bidding system, the experimental invitation-to-bid documents included the simple design instructions with the conditions of the contract such as (i) the requirements for the in-door climate conditions in the case of the green spaces to be connected to the facades, (ii) the daily/weekly hours of the activities/occupation of the specific spaces, (iii) the conceptual drawings (in particular for the investigation of the space to be reserved for the ducts and technical rooms), (iv) the scope of the work as part of the obligations of the contractors, (v) the connections of the district heating, the sprinkler system and the building automation system, (vi) the outer glass shell should be bright and (vii) the basis for calculating the energy consumption and cost (e.g. the prices of the energy items to be used for the life-cycle costs calculations, the discount rate of 6 % and the 25-year life-cycle).

Competitive bidding procedure

The five-member jury carried out the evaluation of the competitive bids. The bidding procedure consisted of two phases as follows.

In the first phase, the required scope of the bids included the system descriptions, the product specifications such as the number and type of the devices, the study of the necessary air volumes and the main distribution networks. The bids were evaluated in particular in terms of five parts: (i) The principle diagrams of the technical systems (e.g. the air conditioning, heat recovery, cooling, heating, sewerage and water systems), (ii) the introductory system descriptions, (iii) the technical rooms, (iv) the special requirements compared with the presumed scope of works and (v) the preliminary life-cycle costs. Seven contractors submitted their ideas on the technical systems and the preliminary costs. The four bids fulfilled the prerequisites for the further involvement.

In the second phase, the four bidders were asked to prepare their final bids with the complete engineering solutions. Some expenses were compensated to all of them. The evaluation criteria consisted of five issues (in the order of priority): (i) the life-cycle costs, (ii) the utilisation of the duplex facade as part of the ventilation, (iii) the flexibility vis-à-vis the future changes of user needs, (iv) the aesthetic value and (v) the maintainability of the systems from the service personnel's point of view. The winning bid was based on the duplex facade and its innovative use for heating the outdoor air-to-air handling units, cooling the constructions with the outdoor air during summer nights and cutting heat losses with the exhaust air stream in the double glass facade during wintertime. The collection of solar heat energy was enabled by installing the collectors into the glass facade.

In Table 22, the three HVAC systems bids are compared on a life cycle basis. The discounting method was based on using the present values. The two bids of EkoAir and Wise required the additional space and, thus, increased the construction costs. MissingLink's bid reduced the costs of the electrical systems. The increments of 13 % were within the capital costs and 19 % within the life-cycle costs in the bids of EkoAir and Wise. The tender examination further indicates an increment of 20 % in capital costs and 6 % in life-cycle costs in Wise and MissingLink bids.

Table 24. Life-cycle based comparison of three HVAC system bids in Example 3

Elements	EkoAir	Wise	MissingLink
Capital cost	€1915180	€2169146	€2596349
Influence on the construction costs	€22033	€51466	€-42048
Present value for the energy consumption for the five years	€291641	€525089	€537872
Heating (MWh/a)	€67	€128	€137
Power (MWh/a)	€32	€55	€45
Present value for the running costs for the five years	€300892	€288845	€72994
Present value for the maintenance costs for the five years	€19174	€3532	€49784
Life-cycle costs	€2549018	€3037862	€3215134
Rank based on the capital costs		2nd (13 %)	3rd (20 %)
Rank based on the life-cycle costs		2nd (19 %)	3rd (6 %)

All the three bids enabled the targeted high building performance, which resulted in selecting the best bid based on the price. A saving of about € 666 000 was achievable between the two bids of EkoAir and MissingLink. In part, the annual energy costs of the winning bid were only about 50 % of the annual energy costs level within the two other bids.

5.3.4 Case study example 4 – Laboratory building (Biocentre3)

Example 4 involves the laboratory building for the University of Helsinki abstracted from Pernu (2000) and Salmikivi (2005). The architect's outline was used as the basis for the competition on the structural frame solution. The mechanical and electrical systems were procured separately. The general contractor was responsible for the design and construction of the foundations, the frame, the roof and the facades. The specialty contractor was responsible for the design and construction of the HVAC system with the energy consumption for the first five years.

In the case of the structural frame, the principles of open building were applied to the bidding procedure. The frame contractors' bids consisted of the structural drawings, the preliminary external works design, the preliminary foundation design, the preliminary elevations, the sections of the structures and the completed performance specification. In the case of the HVAC systems, the invitation-to-bid documents included the outline drawings with the functional and technical requirements as well as the energy consumption calculations. The evaluation was based on both the lowest construction cost and the life-cycle costs. The competition resulted in the five alternative advanced frame solutions and the five different HVAC solutions with the low energy consumption based on the same frame drawings.

5.3.5 Aspects of the examples supporting the STO route

In Table 25, the analogical support that can be rendered from Examples 1-4 to the validity of the elements of the STO route is compiled. In these four examples, the PM teams undertook **the vital responsibilities for coordinating** the overall administration, the designs, the documentation, the contracting/ procurement and the construction works as follows.

- **Overall project administration:** A CM firm provided the overall project programme. The design team performed the traditional administrative work (e.g. checking the conformity, quality). There were no major hindrances in the communication flows between the parties in part due to settling the main issues in the preconstruction phase. The effectiveness of the approach can be tracked down as the award of the third office block to the same CM firm and the STOs as in Example 1. Similarly, **the STO route** allows the continuous checking and the added values through the engagement of many STOs, for example, in a series of projects. Instead of a single design, competing STOS submit many alternative designs based on alternative materials, implementation methods and life-cycle effects in open competition.
- **Building design management:** The designer produced the overall design, the general performance specifications, the primary sketches, the instructions and the other documents for the bidding procedure. In the first phase, the advancement and reliability of the principle designs of the contractors were checked and compared.

Table 25. Results of Examples 1-4 rendering the analogical support to the STO route

Examples	Supportive results based on analogy
Example 1	The project was divided into the specialist tasks. The bidding resulted in the best flexible design of the frame contractor and the design team's drawings for the glass façade, respectively. The healthy competition took place between the specialists in terms of the design, the materials and the life cycle costing. Each task was clearly specified to eliminate problems with task interdependence and schedule adherence. The CM contractor managed the prequalification, the balanced evaluation of the tenders and the choice of the best technical solutions with their beneficial cost and quality implications. The specialty contractors' solutions reduced the cost and shortened the duration without any changes in the quality. No major problems were reported related to communication, co-ordination or co-operation. The advancements were re-gained in the case of the third office block with the same project team.
Example 2	The effective building design documentation supported the arrangement of the competitive bidding procedure based also on the task-specific designs/ solutions. The design team was responsible for the conceptual design and the performance specifications. The pre-qualified specialty contractors were involved early in the design phase. The bid evaluation was based on the technical solution, the cost, the quality criteria, the schedule and the life-cycle costing.
Example 3	The true competition brought about the innovative solutions and the savings in the capital and life-cycle costs. The contractors were involved in the HVAC system design, implementation and maintenance phases. The specialisation brought about the innovative and competitive edge in the award of the contract resulting in the overall savings to the owner.
Example 4	The advanced procurement methods were easy to use both from the perspectives of the owner (client), the designers and the contractors. The bid evaluation could be based in part on the price. The bid expenses were reasonable. The contracts were achieved fast. The full compatibility could be ensured in the early phase in terms of the project parties' relationships and the designs/working drawings. The compatibility of the architectural and technical drawings was reconfirmed before the signing of the contracts. The contractors used their core knowledge effectively in this solution-oriented, high-quality based competitive bidding. No major problems were reported related to communication, co-ordination or co-operation.

In the second phase, the remaining bidders were requested to provide the complete documents. In Examples 2-4, the public procurement directive was applied, i.e. the open tender arrangement. In Example 1, the prequalification exercise was carried out before the invitation-to-bid. Similarly, **the STO route** allows designers produce the overall designs which delineate project dimensions with performance, functional and technical specifications. STOs utilise this information in designing solutions that fit statutory, project and other requirements. Thus, the STO route enhances innovation via specialisation.

- **Contracting/procurement management**: The 2-phase competitive bidding procedures started with the sorting of the qualified bids from among the unqualified ones. For the final phases, there were many discussions or negotiations between the construction manager, the design team, the representatives of the owner (client) and the specialty contractors. Similarly, **the STO route** allows STOs to assume an analogical role of a D-B contractor for their particular tasks, respectively. Each STO has its expertise in a form of a design and construction team in order to improve quality and reduce cost. Each STO's design is incorporated into the overall design (and coordinated with the other STOs' designs). Thereafter, the agreements are signed between the owner and each STO. The owner's designer checks the compatibility of the STOs production plans and schedules. An STO management team provides a general schedule plan that accommodates the interfaces of STOs' tasks. All this is agreed upon before the signing of STO-specific contracts. Thus, any further changes and variations in designs and materials with price fluctuations can be eliminated.
- **Construction works management**: Before the actual construction works were carried out, the CM/PM team inspected the conformity of the construction and installation work plans with the master plan. The final as-built drawings, the detailed system drawings and the documents relating to the structural frame and the HVAC systems were injected into the final design documentation of the project. The coordination was enhanced by the early agreement of the responsibilities for the design, the construction and the PM. There were no contractual agreements between the specialty contractors. Similarly, **the STO route** allows STOs have agreements with the owner only as direct primes under the coordination of the STO management team and with the support of the design team.

5.4 Conclusions

For the validation of the proposed STO route, the initial plan was to test its applicability among Finnish and foreign practicing building project parties via case studies because it was initially explored that many individual specialist tasks were being exploited but not even near the full extent of the suggested STO route. Instead, **the validation consisted of three parts**, i.e. the theoretical, empirical and analogical validation.

The theoretical validation involved the use of the mapping techniques (casual relationship pattern matching) where the STO route was compared with the organic and bureaucracy theories of organisation. This is so since project procurement deals with project organisation and its associated contingencies (e.g. environment, technology and labour intensity). The mapping also revealed the interrelationships between the prevailing procurement methods and the organisation methods and that these are guided by the two organisation theories and the same organisational contingency factors. The CM routes were found to be more flexible than the other prevailing routes, i.e. the former allow for specialisation at the level of special project tasks. The dichotomies of organisational forms such as the formal/informal, centralised/decentralised, routine/specialised and standardised/differentiated are related to most procurement routes. In addition, the structure and performance of an organisation depends on the contingency factors, the project specific variables as well as the organisational design and implementation. The results indicate that the core of the STO organisational structure (from the supply chain perspective) exploits the formal, specialised and differentiated procedures through the decentralised formats under the centralised management system (from the demand chain perspective). This dual form of organisation eliminates the duplication of PM activities.

The empirical validation consisted of the use of the project case questionnaires aimed at finding the correspondence between the prevalent procurement routes and the STO route across the 10 PM performance areas. This was accomplished by identifying the high values of the attributes of the five prevailing procurement routes that also point out to the corresponding high applicability of the STO route. It is herein considered that the amount of 35 project cases is satisfactory for the relevant validation in the context of the small size of the concentrated Finnish building market. Each of the respondents was asked to choose her or his most recent project. Thus, the 35 project cases represent fairly well the recent status of the PM performance in large buildings within the limited market in Finland in the beginning of the 2000s.

The analogical validation was carried out through the review of four case study examples in order to find the analogies between the positive outcomes of four case studies and the elements of the STO route. The original case studies followed the single-case study approach presenting the complete descriptions of the problematic phenomenon within its context (Yin 2003), i.e. the innovative contracting/procurement methods in the building sector in Finland. Examples 1-4 involved the rare innovative building cases in Finland where the specialist contractors were successfully used for advancing some critical sections of four projects, respectively. Examples 1-4 are, thus, eligible for making the analogies between them and the STO route. The analogical validation resulted in supporting the applicability of the STO route in the case of large building projects. In Examples 1-4, the healthy competition and the flexible competitive bidding procedures were based on the design solutions, the constructability, the innovative materials and/or the inclusion of maintainability/FM package in the contract instead of the traditional prevailing routes with the bill-of-quantities approach (based primarily on materials and labour costs). However, it is likely that the adoption of the STO route will be more effective in such national procurement practices where prefabricated systems, elements and products are readily in extensive use (as indicated by Examples 1-4). In addition, the analogical validation supports the previous notion that there is no best procurement route in and out of building season. The validation revealed both the merits and demerits of the integrated, single point of project responsibility as in the D-B contracting and those of the multiple points of project responsibility as in the two CM routes. Thus, the STO route is designed to exploit similar merits and to eliminate similar demerits. Along the STO route, owners benefit through the integrated exploitation of (fragmented) expert knowledge in design, construction materials, building systems and products, construction production methods, value management/engineering and life-cycle costing.

In Table 26, **the support for the STO route** is compiled. The concept of the STO route combines the positive attributes of integration and fragmentation (empirical support). The operational model has a structure based on functional specialisation to suit best large projects (theoretical and analogical support). Effective contractual arrangements are secured between owners and other project parties (empirical and analogical support). Effective communication, co-ordination and co-operation are enabled at both the upper and lower level of integrative management with a MIS (theoretical, empirical and analogical support). Balanced responsibilities/risks can be planned (empirical and analogical support). The in-built value adding mechanisms of the STO route provide owners with more value for their money (theoretical, empirical and analogical validation).

Table 26. Summary of the validation of the STO route

Dimensions	Theoretical, empirical and analogical validation
Concept	Empirical validation: The combined attributes of integration and fragmentation. The STO route utilises the D-B contracting for each STO task, the CM contracting for the involvement both in preconstruction and construction phases, the fragmented project execution of the CM consulting and the traditional GC routes via many task organisations. The relationships ratings of the procurement routes support the use of the STO as a better route through the incorporation of many features of the prevailing routes.
Operational model	Theoretical and analogical validation: The STO route exploits a viable organisation structure that is decentralised in power and authority, high on documentation/formalisation, with low task uncertainty up to the procurement phase and with definitive tasks during the construction phase, high on functional specialisation, with the interdependence of functions and self-directed teams. Contingencies may involve large projects, open building concept/prefabrication, product standardisation and the role of an integrator due to high task divisionalisation/differentiation.
Contractual arrangements	Empirical and analogical validation: The STO route enjoys the benefits of the direct contractual relationships between an owner and all other stakeholders. An STO management team assumes a fiduciary role and administers the works of STOs. On behalf of the owner, the team provides STOs with common site facilities. STOs have direct contracts with an owner and they bear performance risks and responsibilities.
Communication, co-ordination and co-operation	Theoretical, empirical and analogical validation: In the upper level of the STO route, the integrative management of the management team is enabled though a MIS and Internet. The interaction of STOs in schedule adherence and the connectivity of their solutions encourage co-operation.
Balanced responsibility/ risk allocation	Empirical and analogical validation: An owner holds all primary project risks. He is responsible for the provision of common site facilities. Designers are responsible for overall designs and they carry only risks related to this design work. STOs bear (non-) performance risks and responsibilities for both technical engineering designs and actual construction works.
Value-adding areas	Theoretical, empirical and analogical validation: Specialisation of the fragmented tasks brings about additional values into the determination of users' requirements, the supply chain re-engineering, the FM contracts (as part of STOs' contracts) and the short feedback loops.

6 SUMMARY

6.1 Setting and the Key Results of the Study

Across many national practices, there is a huge potential of adding markedly more value for both owners' money and building construction success through the re-engineering of contracting/procurement methods. Hence, **the main aim** of this study is to develop a novel procurement method that enables owners and users to attain their building project objectives. Primarily, the new STO route is designed to advance national procurement practices vis-à-vis the prevailing procurement routes in the primary context of large building projects in Finland. **The research methodology** was planned to ensure the successful conduct of the new concept design and validation process. In part, the constructive research method of Kasanen et al. (1993) was adopted to serve as a frame of reference for this study process.

The comparative theoretical-empirical analysis of the CM contracting systems, practices and the five prevailing procurement routes in the USA, the UK and Finland served as the basis for the design a new STO route. The comparison revealed the growing reliance in CM procurement routes in the USA and Finland as well as the dominance of D-B contracting in the UK. These divergent national developments buttress the fact that local conditions (e.g. construction environment, building market and the level of technology) dictate the conditions for contracting/procurement success. Essentially, all procurement is fragmented in operational sense as there is the involvement of several internal and external project parties from an owner's (client's) point of view through a series of contractual relationships, responsibility distribution and risk allocation. There are alternative ways of executing projects, which implies the existence of many hybrids of the prevailing procurement routes. Versatile applications, variations and hybrids complicate the categorising and/or identification of procurement routes. Many routes are mistakenly labelled according to related financial incentives and compensation methods. In particular, the identified severe problems are related to the unbalanced responsibility/risk division between owners, CM firms, contractors and other project parties. Risks are placed on owners or various contractors depending on the reliance on particular procurement routes.

The five prevailing procurement routes, i.e. the traditional general contracting without (GC-t) and with separate trades (GC-st), the CM consulting, the risk-carrying CM contracting and the D-B contracting have strengths and weaknesses on different variables, respectively, such as building performance, schedule compression and on-time completion, quality, cost effectiveness and relationships between project parties.

The proposed specialist task organisation (STO) route utilises the merits of both fragmentation and integration and eliminates their weaknesses. At the same time, the STO route combines many merits of the prevailing procurement routes (e.g. integrated D-B contracting) and eliminates their inherent weaknesses. Both single (integrated) and multiple (fragmented) points of project responsibility/risk are incorporated into the STO route. The scope of each building is divided into a set of 5-8 fragmented tasks. In turn, the STO management team ensures the integration of the project realisation across all tasks and through all phases. The STO route increases competition in order to produce better building designs and specifications through the early involvement of specialist designs, alternative materials, maintainability and life-cycle costing. The adoption of the STO route has positive effects on building (object) performance as well as project quality, cost and schedule by allowing flexibility in building design, contracting/procurement, construction and maintenance. It is proposed that the STO route adds more value to building projects than any of the prevailing procurement routes accomplishes today. In part, this is so because the STO route exploits short feedback loops and arranges competitions along many performance-based factors.

Evolving STO managers or management teams oversee the overall design, site services, contracts, IT management, site supervision and administration as well as the construction task performance of STOs at sites. The reliance on dynamic STO management firms is likely to result in higher effectiveness than in the traditional case of firms being responsible for either total management task or construction works. The division of the scope of building projects into a set of tasks can be specified in detail so that the overlapping of responsibilities is avoided. Responsibilities on many blurred issues like negligence and incompetence can be readily incorporated in contracts on building designs and other specialist tasks as part of the contract management along the STO route. The management principles allow contractors specialise themselves and focus on their core tasks (packages, sub-systems or parts). When the expertise of STOs on site, environmental, statutory and contracting requirements is combined with the innovative solutions of designers, building owners and STO managers can together set more demanding but achievable goals, choose a clear project/procurement strategy and enhance commitment to each project and partnering spirit. In turn, all this reduces conflicts, time wasting and, subsequently, project costs.

In particular, it seems that **life-cycle management and services** (incl. FM services) become one of the primary criteria for all advanced procurement routes. For example, a 5-year in-door climate responsibility and a building FM services plan are being adopted as the latest criterion (for the evaluation of bids).

The high operational effectiveness of the STO route is based on the specialisation of task organisations from project development/building design up to project execution with the fragmentation of design and construction processes since many STOs are involved. Within the US, UK and Finnish practices, the involvement of STOs is today too narrow vis-à-vis all project phases and nearly neglected during the later phases of the life-cycles of building stocks.

6.2 Conduct and the Contribution of the Study

Within a frame of the constructive research approach (Kasanen et al. 1993), **the conduct of this study** took place with reliance on the established research procedures and the operational measures that are also documented in detail in this report. This allows interested scholars and readers to check the reliability of every step. The initial theoretical connections were made to the literature in a form of the analysis of the state of contracting/procurement art in order to define the knowledge gap and to specify the research problem. Thus, the critical problem of better contracting/procurement was chosen and investigated in-depth in the context of four national procurement practices in the USA, the UK and Finland. The extensive review of the national contracting systems and procurement practices was carried out covering contractual arrangements, project responsibility distribution, risk allocation and compensation methods.

Based on the combined sound theoretical and empirical bases, **the new STO route** was designed. The suggested STO route was validated along the principle of triangulation through the theoretical validation (against the organic and bureaucracy organisation theories), empirical validation (the project cases survey with the complementary interviews) and analogical validation (Examples 1-4). In principle, the validation of the suggested STO route can be carried out in many other ways (e.g. through a project pilot). At the end of the day, the 3-part validation was seen as the relevant way out from the severe limitations that this researcher met during the study, i.e. especially the denials of direct access to real project cases. In order to prevent this type of problems from occurring in the future, foreign students with similar in-depth studies are advised to look for avenues for empirical investigations within their home countries or to form an alliance with a native or local research team with overlapping research problems.

The STO route complements many innovative approaches and it adds to the body of contracting/procurement management knowledge. The results of the 3-part validation indicate **the novelty of the STO route** as a theoretical contribution and point out to a modest practical applicability of the STO route at minimum. In other words, the adoption of the STO route is likely to result in cost reductions, timely completions and project quality improvements. At the same time, many unknown or design laxities, reworks, variations, claims and project abandonment are avoided ensuring, subsequently, effective PM performance and high owner (client) satisfaction. Overall, it is herein posited that the resultant STO route is a theoretically significant contribution and that it is also applicable among practitioners in the national building sector both inside and outside Finland.

6.3 Suggestions for Future Studies

The suggestions for future research are put forth in particular in order to advance further the elements of the STO route and similar emerging procurement routes across national building practices as follows.

A series of future complementary studies is herein promoted in order to have an in-depth understanding of the management of each PM performance variable with measurements in both preconstruction and construction phases and among project parties through pilot or real STO(-like) projects across various national building sectors. In the same vein, the conditions for the high effectiveness of integrative STO management systems could be revealed in particular in the area of communication, co-ordination and co-operation management through pilot cases. Comparative pilot research might involve the testing of a large number of projects with involved parties even outside Finland. For the time being, **the STO route cannot be validated as a whole** with a single-case or multiple-case study because this new route is not used among practitioners in Finland or elsewhere. For example, partial analogical case examples help to validate the STO route only indirectly. Thus, more additional (pilot) cases and tests could be carried out also in the international context to advance both the theoretical constructs and the practical usefulness of the STO route.

Additional empirical inquiries could be launched to advance the STO route and its ways of distributing responsibilities, allocating risks, arranging contractual relationships, managing inter-party relationships through all project phases, choosing compensation methods and managing project schedules among potential STOs. In addition, **IT management systems** are suggested as a tool for managing STOs' activities and as a knowledge database for future learning. All the parties could use this information in future research and product developments in order to reduce the exposure of owners to financial, liability and responsibility risks. Initially, similar MIS tools have been successfully applied in the case project examples via a web-based management system.

The comparison of the prevailing procurement practices could be deepened via addressing various project parties that belong to a spectrum of building design, consulting, contracting and supplies. Their current competences and development programs could be diagnosed around the five value adding areas within the STO route in terms of cost, quality, schedule, inter-relations, performance, procurement types, etc. These five value adding areas could be examined in-depth to learn flexibilities and rigidities inherent in procurement processes, relationships, financing and lice-cycle/FM services.

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APPENDICES

Appendix 1. Questionnaires.

SUKE: DEVELOPMENET OF A DESIGN SYSTEM OF CONSTRUCTION MANAGEMENT CONTRACTS IN BUILDING PROJECTS/ Kruus, M., Oyegoke, A., Kiiras, J. (16 June 2004)

Please note that the questionnaire consists of 6 parts

Part 1: General information about the respondent

a) Name				**b) Address**					
c) Telephone				**d) Email**					
e) Company									
f) Practice (firm)		Consultants		Contractors		Govt.		Education		Others
g) Discipline		Owner		Architect		Engineer		Project manager		Contractor
		Construction manager		Supplier		Subcontractor				
h) Contractual arrangement recently used									
i) Respondent's role in the project									
j) Follow up interviews		Yes		No					

Part 2: Project descriptions

Please share your experience in your most recent completed project

a) Name and address of the project (it will not be used in any publication)							
b) Year of completion		c) Floor area		Volume			
d) Project special features if any							
e) Project type		Apartment		Office		Factory	
		Institution		Infrastruct-ure		others	
f) Form of contract		BOT		Design and build		General contract		CM
		BOOT		Novation			
		DBO		Bridging			

Part 3: Project parties and processes			
Please name the executor of tasks and add the organisation if possible.			
Parties/Tasks	Name the organisation that carries out the work	Contractual relationship with	Compensation methods
Owner			
User(s)			
Developer			
Owner representative			
Main designer			
Feasibility studies done by			
Project manager in design phase			
Project manager in execution phase			
Programmer			
Schematic designer			
Designer in working drawing stage			
HEPAC engineering designer			
Site supervision			
Procurement process done by			
Main contractor			
Structural contractor			
Heating and ventilation contractor			
Site management			
Site facilities			
Compensation methods			

Part 4: Schedule

Please draw the project schedule in relation to the tasks. Enclose the project schedule if possible

Tasks	Schedule in months																																								
Programming																																										
Schematic design																																										
Working drawing																																										
Technical stage																																										
Procurement																																										
Frame and envelop structure																																										
Fit-out construction (infill) of the building																																										
Use of the building																																										
Combined cell represents 6 months							6 months																																			

Part 5: Design and engineering			
Who made the drawings and did anyone revise those drawings? Please add xtra procurement if any as well as this project procurement division and schedule.			
Building elements and components	Name of the specialty (product) contractor	Is the engineering design done by the specialty contractor	Contractual relationship with the specialty contractor
Substructure			
Frame			
External wall and cladding			
Roofing			
Glass structures (wall, roof, etc)			
Floor coatings			
Ceilings			
Partitions			
		Yes/No	

Part 6: Performance and relationship measurement between the parties						
What are your opinions about the relationship between the parties, project performance and method used in this project? Do write your suggestions for improvements.						
a) Please rank relationships between the parties on a scale of 1-5: very cordial (5) ....(1) not cordial						
Phases	Owner & Consultants	Owner & Contractors	Between consultants	Consultants & Contractors	Contractors & Subcontractor	Improvements (if any):
Design phase						
Construction phase						
b) Please rate project performance factors on scale of 1-5: best (5) ... (1) worst						
Themes		Rating		Proposed improvement:		
Project target attainment						
Client's satisfaction						
Client's budget attainment						
Completion time						
Quality						
Technical quality						
Responsibilities/risks						
Contracting methods						
Design management						

Appendix 2. Management of overall project risk based on the PMI and the standard form of agreement between owner and CM (CMAA No. A-1).

Consulting CM CMAA Document No. A-1 (1993 Edition)							
Theme	**Project phases**	**Planning**	**Assessment**			**Management**	
		Management planning	**Identification**	**Analysis**		**Response planning**	**Monitoring & control**
				Qualitative	**Quantitative**		
Project mana-gement	Pre-design 3.2.1	Design professional selection and contract preparation	Design requirements; budget, scope, environmental conditions etc.	Design professional orientation and criteria for selection	Owner's requirements/ cost analysis/ statutory requirements	Project procedure manual, alternative schedule and management methods	Construction management plan and design professional orientation session
	Design 3.3.1	Design phase information	Design documents and project funding	Design document	Owner/CM reviews/ project requirements	Periodic project meetings and conferences	CMP and approval by regulatory agencies
	Procur-ement/ Bid and award 3.4.1	Pre-bid conference	Bidder's interest campaign	Prequalific-ation of bidders	Bid opening, evaluation and recommenda-tion	Pre-bid and post-bid conferences	Compliance with construction contracts execution
	Constru-ction 3.5.1	Pre-construction conference	Construction process efficiency	Permits, bonds and insurance	Variation and change orders	Construction administration procedures	Contractor's safety/quality program review
	Post-constru-ction 3.6.1	Effective record documentatio n	Occupancy permit	Operations and maintanen-ce manuals	Operation manuals, warranties and certificates	Co-ordination of final testing and final inspections	Documentation submission governmental officials during inspection
Time mana-gement	Pre-design 3.2.2	Master schedule	Time overruns	Master schedule	Design/projec t schedules	Design phase milestone schedule	Construction management plan updates
	Design 3.3.2	Pre-bid construction schedule	Realistic design phase schedule	Revisions to master schedule	Milestone/pre -bid construction schedule	Pre-bid construction schedule	Milestone and pre-bid construction schedules
	Procur-ement/ Bid and award 3.4.2	Pre-bid construction schedule	Contractor's construction schedule	Contractor's schedule responsibili ties	Revision of milestone schedule	Information to bidders on revisions to master schedule	Contractor's construction schedule
	Constru-ction 3.5.2	Contractor's construction schedule	Construction schedule	Recovery schedules	Effect of change order on schedule	Periodic construction schedule report	Schedule compliance and construction progress
	Post-constr-uction 3.6.2	Occupancy plan	Occupancy plan	Location schedule for materials	Location schedule/Mov e-in frequency	Owner's ratification of location schedule	Occupancy plan

Appendix 2 (cont’d)

Cost manag-ement	Pre-design 3.2.3	Construction market survey	Project and construction budget(s)	Budgets with design professional and owner	Cost analysis, usable life, energy studies, etc.	Various design and construction alternatives	Project and construction budgets
	Design 3.3.3	Estimate of construction cost	Project estimates	Revision of project and constructio n budget	Value analysis studies	Revision and recommendati ons on project and construction budget	Cost control and monitoring
	Procur-ement/ Bid and award 3.4.3	Estimate of addenda	Bid analysis and negotiation	Evaluate alternative bids and unit prices	Cost analysis, usable life, energy studies, etc.	Construction contract recommendati ons	Estimate of cost for addenda
	Constru-ction 3.5.3	Trade-off studies on materials, systems, etc.	Project costs overruns	Effect of change order on cost	Allocation of cost to contractor's construction schedule	Contract price allocations	Cost records and progress payments
	Post-constru-ction 3.6.3	Effect of change order on the project	Total project cost	Unresolved change order	All change order	Unresolved change orders with cost impact	Project costs and prepare final cost report
Manag-ement informa-tion system (MIS)	Pre-design 3.2.4	Establishment of MIS	Project MIS	Design phase MIS procedures	Project stakeholders interviews	Communicati on between project stakeholders	Procedures for reporting, communications and administration
	Design 3.3.4	Schedule reports	Design phase information flow	Project cost reports	Actual vs. scheduled progress	Design phase change reports	Project cost and cash flow reports
	Procur-ement/ Bid and award 3.4.4	Project cost reports	Securing of bidders	Actual price vs. contemplate d budget	Actual costs vs. estimated costs	Reports e.g. project cost reports etc.	Project cost reports, cash flow reports and schedule maintenance reports
	Constru-ction 3.5.4	Project and construction budget revision	Efficiency in construction process	Project and constructio n budget revision	Actual costs and schedule vs. estimated costs and schedule	Reports e.g. progress payment reports	Project cost reports, cash flow reports and schedule maintenance reports
	Post-constru-ction 3.6.4	Close out reports	Project maintenance	Final project accounting	Occupancy planning	MIS reports for occupancy	MIS reports for occupancy and close out reports

Appendix 3. Management of overall project risk based on the PMI and the standard form of agreement between owner and CM (CMAA No. GMP-1).

Theme	Project phases	Planning	Assessment			Management	
		Management planning	Identification	Analysis		Response planning	Monitoring & control
				Qualitative	Quantitative		
Project mana-gement	Pre-design 3.2.1	Design professional selection and contract preparation	Design requirements; budget, scope, environmental conditions etc.	Design professional orientation and criteria for selection	Owner's requirements/ cost analysis/ statutory requiremen-ts	Project procedure manual, and alternative schedule and management methods	CM plan and design professional orientation session
	Design 3.3.1	Design phase information	Review of design documents and project funding	Design document	Owner/CM reviews/ project requirements	Design recommendati-ons, periodic project meetings	CM plan and approval by regulatory agencies
	Procur-ement /Bid and award 3.4.1	Pre-bid conference	Bidder's interest campaign	Prequalifica tion of bidders	Bid opening and evaluation	Pre-bid and post-bid and pre-construction conferences	Permits, insurance and labour affidavits
	Constru-ction 3.5.1	Determination of substantial completion	Construction process efficiency	Operation and maintena-nce materials	Variation and change orders	Construction administration procedures	Quality management and quality review
	Post-constru-ction 3.6.1	Effective record documenta-tion	Occupancy permit	Index operations and maintenanc e materials	Operation manuals, warranties and certificates	Co-ordination of final testing and final inspections	Documentation and accompanying governmental officials during inspection
Time mana-gement	Pre-design 3.2.2	Master schedule	Time overruns	Master schedule	Design/ project schedules	Design phase milestone schedule	CM plan updates
	Design 3.3.2	Pre-bid construction schedule	Realistic design phase schedule	Revisions to master schedule	Milestone/ pre-bid construction schedule	Pre-bid construction schedule	Milestone and pre-bid construction schedules
	Procur-ement/ Bid and award 3.4.2	Pre-bid construction schedule	Contractor's construction schedule	Contractor's schedule responsibili ties	Revision of milestone schedule	Inform bidders on revisions to master schedule	Contractor's construction schedule
	Constru-ction 3.5.2	Contractor's construction schedule	Construction schedule	Recovery schedules	Effect of change order on schedule	Periodic construction schedule report	Schedule compliance and construction progress
	Post-constru-ction 3.6.2	Occupancy plan	Occupancy plan	Location schedule for materials	Location schedule/Mov e-in frequency	Owner's ratification of location schedule	Occupancy plan

Appendix 3 (cont'd)

Cost mana-gement	Pre-design 3.2.3	Construction market survey	Project and construction budget(s)	Budgets with design professional and owner	Cost analysis, usable life, energy studies, etc.	Various design and construction alternatives	Project and construction budgets
	Design 3.3.3	Estimate of construction cost	Project estimates	Revision of project and constructio n budget	Value analysis studies	Revision and recommendation s on project and construction budget	Cost control and monitoring
	Procure ment/ Bid and award 3.4.3	Estimate of addenda	Bid analysis and negotiation	Evaluate alternative bids and unit prices	Cost analysis, usable life, energy studies, etc.	Construction contract recommendation s	Estimate of cost for addenda
	Constru ction 3.5.3	Trade-off studies on materials, systems, etc.	Project costs overruns	Effect of change order on cost	Allocation of cost to contractor's construction schedule	Periodic site meeting	Cost records and progress payments
	Post-constru-ction 3.6.3	Effect of change order on the project	Total project cost	Unresolved change order	All change order	Unresolved change orders with cost impact	Costs and prepare final cost report
Mana-gement informa-tion system (MIS)	Pre-design 3.2.4	Establishment of MIS	Project MIS	Design phase MIS procedures	Project stakeholders interviews	Communication between project stakeholders	Procedures for reporting, communications and administration
	Design 3.3.4	Schedule reports	Design phase information flow	Project cost reports	Actual vs. scheduled progress	Design phase change reports	Project cost and cash flow reports
	Procur-ement /Bid and award 3.4.4	Project cost reports	Securing of bidders	Actual price vs.contempl ated budget	Actual costs vs. estimated costs	Reports e.g. project cost reports	Project cost reports, cash flow reports and schedule maintenance reports
	Constru-ction 3.5.4	Project and construction budget revision	Efficiency in construction process	Project and constructio n budget revision	Actual costs and schedule vs. estimated costs and schedule	Reports e.g. contractor's safety report	Project cost reports, cash flow reports and schedule maintenance reports
	Post-constru-ction 3.6.4	Close out reports	Project maintenance	Final project accounting	Occupancy planning	MIS reports for occupancy	MIS reports for occupancy and close out reports

Appendix 4. Management of overall project risk based on the PMI and the CMAA standard CM services and practice.

Themes	Project phases	Planning	Assessment			Management	
		Management planning	Identification	Analysis		Response planning	Monitoring & control
				Qualitative	Quantitative		
Project manage-ment	Pre-design	Organisation of a project team with the owner	Project organisation & project requirements	Relation-ship btw the stake-holders	Team member responsibility-ies	MIS	CMP and PPM
	Design	Pre-design project conference	Design documents and project funding	Design document review	Contract agreement review	Periodic project meetings	Cost and time control
	Procu-rement	On-going consulting activities	Bidding and contracting process	Provision for permits, insurance and labour affidavits	Bid opening and evaluation	Pre-bid meetings, bid opening and pre-award conferences	Compliance with construction contracts execution
	Const-ruction	Professional planning and project execution	Construction process efficiency	Verified on and off site facilities	Cost, time and quality compliance with plan	On-site meeting and management reporting	Claims, time and quality management, and management reporting
	Post-constr-uction	Effective project documents transmission	Effective project close-out	Verified documents related to move-in or start-up	Manuals and assemble record drawings	Final documents e.g. final cost report	Post-construction project/contract administration
Cost manage-ment	Pre-design	Preliminary cost investigation	Project and construction budget(s)	Budgets/ cost limitation reviews	Cost analysis, LCC, energy studies, etc.	Allowance for design contingency	CMP and cost reports
	Design	Preliminary design estimate	Project estimates	Verified construct-ion and project budgets	Value analysis studies	Design estimate/cost management	Cost monitoring and reporting
	Procu-rement	Estimate of addenda	Bid analysis and negotiation	Evaluated alternative bids and unit prices	Bid analysis	Bid negotiation	Pricing methodology in the final estimates
	Const-ruction	Trade-off studies on materials, systems, etc.	Project costs overruns	Change order control	Forward and post pricing	Detailed audit record e.g. for claims	Cost management procedures
	Post-constr-uction	Summary of total project costs	Total project cost	Unresolved issue with cost impact	List of all change order	Unresolved issues with cost impact	Project costs monitoring and final cost report

Appendix 4 (cont'd)

Time manage-ment	Pre-design	Sequencing, management and imple-mentation of design	Schedule adherence	Master schedule	Key events from master schedule - milestone schedule	Construction schedule	Monitoring of schedules and prepare periodic reports
	Design	Revision of master schedule	Realistic design phase schedule	Revision of master schedule	Milestone compared with construction schedule	Management of float	Milestone and construction schedules
	Procu-rement	Pre-bid construction schedule	Contractor's construct-ion schedule	Clarification of contractor's schedule responsibil-ities	MS compared with contractor's construction schedule	Contractor participation in schedule development	Monitoring of contractor's construction schedule
	Const-ruction	Schedule compliance monitoring	Construct-ion schedule	Ways for contractor's to recover lost schedules	Extensions/impact analysis	Recovery schedules and claim review	Schedule compliance and construction progress
	Post-constr-uction	Occupancy plan	Occupancy plan	Participant in occupancy plan	Move-in frequency	Government reviews and certification	Monitoring of occupancy plan
Quality manage-ment	Pre-design	Clarification of owner's objectives	Quality manage-ment organisa-tion	Methodology for quality control	Review of scope of work and quality control	Quality management plan	Quality management, control and assurance
	Design	Manage design process/ design procedure	Document control/ design quality	Constructab-ility reviews and QM specifications	Testing requirement, value engineering etc.	Project review meetings and reports	Funding, quality control and assurance
	Procu-rement	Procurement planning	Contractor's selection	Proposal document protocol and bid opening	Advertiseme-nt and solicitation of bids,	Instructions to bidders and pre-bid conference	Pre-award conference with a successful bidder
	Con-struct-ion	Precon-struction conference	Construct-ion quality	Report and recordkeeping, and changes in the work	Inspection and testing, checking work quality	Final review, documentation and punch list work	Issuance of progress payment and certificate of final acceptance
	Post-con-struct-ion	Pre-warrantee check-outs	Operations and maintenan-ce manuals	Review of overall quality management	Quality management assessment with the owner	Quality management plan	Final report and recommendations

Appendix 4 (cont'd)

Project contract/ admini-stration	Pre-design	Communica-tion flow	Project administra-tion and reporting	Communica-tion procedures	Record and control of the flow of submittals	Communication procedures	Record and control of the flow of submittals
	Design	Systematic flow of information	Design phase progress	Consultation among team member	Project cost compared with project budget	Design review meetings	Schedule management and project cost report
	Procu-rement	Bidder pre-qualification	Securing of bidders	Bidders list	Bid opening and evaluation, and review addenda	Pre-bid conferences and meeting, and post bid interview	Cost, cash flow and schedule maintenance report
	Const-ruction	Pre-construction orientation conference	Efficiency in con-struction process	On site communica-tion and contract docu-mentation procedures	Quality review/non-conforming work	Proof of insurance, permits, bonds, etc.	Project site meetings, field reporting, special record keeping etc.
	Post-constru ction	Requirement for spare parts and warranties	Project mainten-ance	Maintenance manuals and operating procedures	Move-in/start-up activities	Contractor call-backs	Contract close out, final payment, and close out report
Safety manage-ment services	Pre-design	Owner's commitment	Project safety	Safety management options	Safety program organisation staffing	CM safety coordinator	Certified safety professional
	Design	Project scope understanding	Design safety	Review of drawings with design team	Potential hazards/speci-fic safety devices	Safety input to construction contract documents	Mitigation of potential hazards by providing safety devices
	Pre-bid	Pre-bid conference	Perform-ance safety	Guidelines/ responsibil-ities	Safety performance as pre-qualification	Written safety program and emergency response coordination	Contract requirements and drafting guidelines
	Pre-constru ction	Pre-construction conference	Construct-ion safety	Review of safety submittals	Review of contractor's jobsite safety program	Emergency response programs and procedures	Communication with compliance agencies
	Constr uction	Contractor safety enforcement and compliance	Project safety	Safety enforcement and compliance	Job hazard analysis	CM safety training	Safety audits, safety coordination meetings and monthly reports

MIS - management information systems; **CMP** - construction management plan; **PPM** - project procedures manual; **LCC** - life cycle costing; **MS** - master schedule; **CCS** - contractor's construction schedule; **QMP** - quality management plan; **VEA** - value engineering analysis; **QMS** - quality management specifications; **N&A** - Notice and advertisement; **MM&O** - Maintenance manuals and operating procedures

Appendix 5. Responsibility and risk distribution in CM contracting systems.

	Theme	US		UK	
		Agency	CM at-risk	CMC	MC
Preconstruction phase	General services (CM/MC)	Advice on VE & VM & constructability	Advice on VE & VM & constructability	Advice on VE & VM & constructability	Advice on VE & VM & constructability
	Design responsibility	Design team	Design team	Design team	Design team
	Trade/Works/ Subcontracts	Trade contractors are agent of the owner, held by CM	CM holds subcontractors or owner holds subcontractors; assigned to CM	MC holds works contractors	MC holds works contractors (*JCT Works Contract 3*) & agreement with the Owner
	Selection process	CM recommends/ advises, Owner selects the trade contractors	CM decides/selects subcontractor with owner approval	Professional team, CMC & Owner	Professional team, MC & owner
	Project Supervision/ Co-ordination	Supervise, co-ordinate & administer project (CM)	Supervise, co-ordinate & administer project (CM)	Provide management services in conjunction with a professional team (CMC)	Provide management services in conjunction with a professional team (MC)
	Investment risk	Owner's risk	Owner's risk	Owner's risk	Owner's risk
Construction phase	General services (CM/MC)	Administer contracts (agent/advisor A201/CMa)	Directly controls the work (constructor A121/CMc)	Administer and supervise contracts	Administer contracts & provide special facilities
	Cost risk	Owner's risk	Optional (with GMP)	Owner's risk	MC's risk
	Schedule risk	Owner's risk	Optional	Owner's risk	MC's risk
	Quality risk	Owner's risk	CM's risk	Owner's risk	Works contractor's risk
	Performance risk	Owner's risk	CM's risk	Owner's risk	Works contractor's risk
	Safety risk	Owner's risk	CM's risk with Subs.	Owner's risk	MC's risk
	Hazardous materials on site	Owner's risk	Owner's risk	Owner's risk	Owner's risk
	Construction means & methods	Owner's risk	CM responsibility	Owner's risk	Works contractor's risk
	Force majeure	Owner's risk	Owner's risk	Owner's risk	Owner's risk
	Payment	Owner to CM (fee); Owner to Trade contractors	Owner to CM (fee); CM to subcontractors	Owner to CMC (fee); Owner to Works contractors	Owner to MC; MC to works contractors

Appendix 5 cont'd

Construction phase (cont'd)	Indemnity	CM to Owner; Owner to CM; Trade contractors to Owner & CM	CM to Owner; Subcontractors to Owner & CM	CMC to Owner; Owner to CMC; Works contractors to Owner & CMC	MC to Owner; Owner to MC; Works contractor to MC & Owner
	Insurance	General liability by each stakeholder Builder's risk by Owner Professional liability by Designer	General liability by each stakeholder Builder's risk by Owner Professional liability by Designer	General liability by each stakeholder Builder's risk by Owner Professional liability by Designer	General liability by each stakeholder; All risk insurance by Owner & MC; Insurance of existing structure and contents by Owner; Injury to persons and property and indemnity to Owner; Insurance against injury to persons or property by MC & Works contractors
	Dispute resolution Owner-CM	Discussion - mediation - arbitration	Mediation - arbitration	Adjudication - arbitration - legal proceedings	Adjudication - arbitration - legal proceedings

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