



## **In the pursuit of sustainable building renovation strategic partnerships and new business models in construction**

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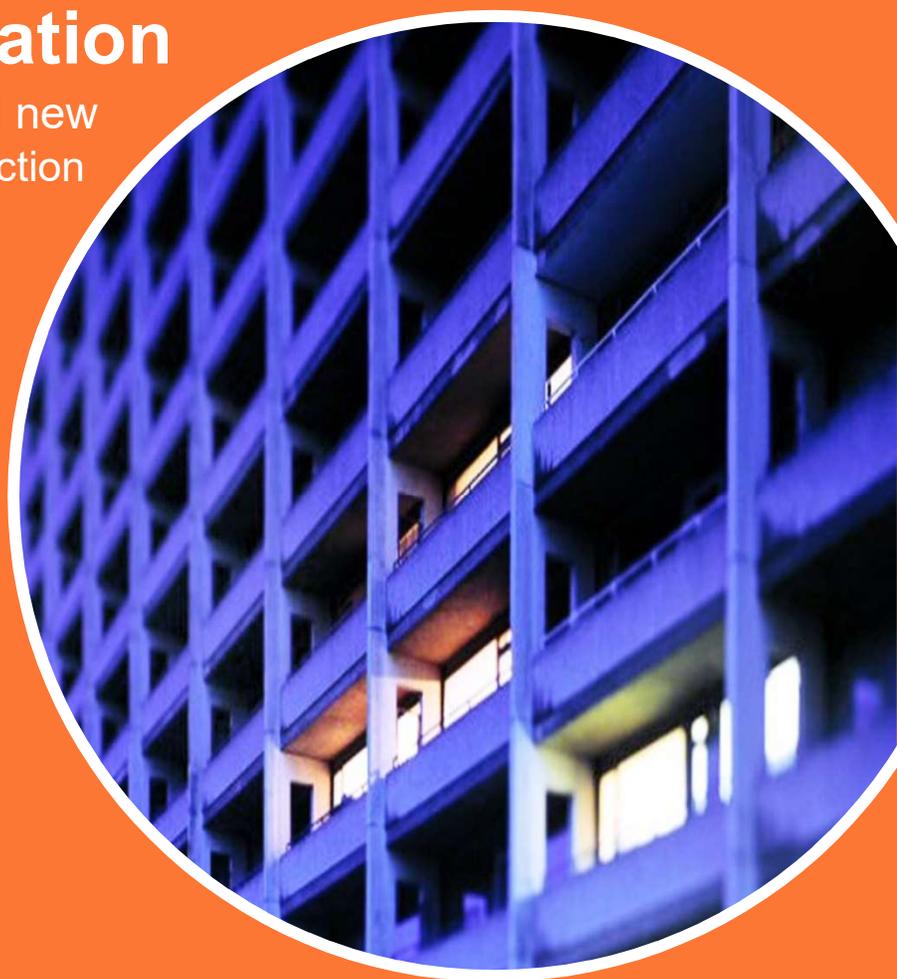
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# In the pursuit of sustainable building renovation

strategic partnerships and new  
business models in construction



**Jakob Brinkø Berg**

PhD thesis  
June 2022

Technical University of Denmark

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## SUMMARY

As the building stock of the industrialized nations of the world ages and the demand for lower resource use, social responsibility and economic benefits increase in society, the increase in sustainable renovation projects is inevitable. This increases the complexity of building projects and traditional procurement methods often do not yield satisfactory results, leading some building clients to seek new ways of procuring building services, such as strategic partnerships.

This leads to the key question this PhD thesis seeks to answer. When introducing a new relational contract type, such as strategic partnerships, how does this change the dynamics in the construction value chain?

As part of the PhD research's theoretical framing Transaction Cost Economics enables analysis of change in procurement strategy and the suitability of relational contracts. Maturity models was used to evaluate organisational maturity when changing procurement practices and business models were used to examine how the companies in the construction value chain are challenged when entering into strategic partnerships. Since the subject of the research was organisations and companies a research philosophy of critical realism was used together with an abductive research approach. Both scoping and structured literature reviews were used to ground the research in the scientific literature. Using interviews, workshops, surveys, and case studies a mixed method research approach was used to insure reliability and validity. Practitioner interviews and workshops, public procurement documents and case descriptions have given the research a solid empirical footing.

The results of the PhD research is a definition of the Danish model of strategic partnerships, the Construction Supply Chain Transaction maturity model, four construction value chain business model archetypes coupled with friction analysis and a taxonomy of relational contracts. The research has created a model for implementing innovative procurement practices in construction and maturity models to support procurement decisions in building client organisations, including strategic partnerships. It has also produced business model archetypes to analyse friction when Architect, Engineering and Contracting (AEC) companies and producers of building materials enter into strategic partnerships. Based on the literature reviews conducted, a taxonomy of relational contracts was created showing the connections between Strategic Partnerships and the established relational contract types; Partnering, Alliancing and Integrated Project Delivery.

The work is relevant for practitioners, as it supports implementing new procurement strategies, developing organisational maturity and business models analysis tools to support strategic partnerships. A number of the results and models produced by the study have general applicability both in the construction industry and in other industries. These are also relevant for academics, who wish to develop definitions for types of relational contracts, models for organisational change or make research on business model innovation in the construction industry.

## RESUMÉ (DANISH)

Efterhånden som bygningsmassen i de industrialiserede nationer i verden ældes, og efterspørgslen efter lavere ressourceforbrug, større social og økonomisk ansvarlighed stiger i samfundet, er stigningen i bæredygtige renoveringsprojekter uundgåelig. Dette øger kompleksiteten af byggeprojekter, og traditionelle indkøbsmetoder giver ikke tilfredsstillende resultater, hvilket får nogle bygherre til at søge nye måder at indkøbe byggedelser på, såsom strategiske partnerskaber.

Dette leder til det centrale spørgsmål, som denne ph.d.-afhandling søger at besvare. Når der introduceres en ny relationel kontrakttype såsom strategiske partnerskaber, hvordan ændrer dette dynamikken i byggeriets værdikæde?

Som en del af ph.d.-forskningens teoretiske udformning muliggør Transaction Cost Economics analyse af ændringer i indkøbsstrategi og egnetheden af relationelle kontrakter.

Modenhedsmodeller blev brugt til at evaluere organisatorisk modenhed ved ændring af indkøbspraksis og forretningsmodeller blev brugt til at undersøge, hvordan virksomhederne i byggeriets værdikæde udfordres, når de indgår i strategiske partnerskaber. Da det forskningsmæssige fokus var organisationer og virksomheder, blev kritisk realisme brugt som forskningsfilosofi sammen med en abduktiv forskningstilgang. Både scoping og strukturerede litteraturgennemgange blev brugt til at forankre forskningen i den videnskabelige litteratur. Ved at bruge interviews, workshops, spørgeskemaer og casestudier blev der brugt en "mixed method" forskningsstrategi til at sikre pålidelighed og validitet. Praktiser interviews og workshops, offentlige udbudsdokumenter og casebeskrivelser har givet forskningen et solidt empirisk fundament.

Resultaterne af ph.d.-forskningen er en definition af den danske model for strategiske partnerskaber, Construction Supply Chain Transaction modenhedsmodellen, fire forretningsmodelarketyper fra byggeriets værdikæde koblet med friktionsanalyse og en taksonomi af relationelle kontrakter. Forskningen har skabt en model for implementering af innovative indkøbspraksis i byggeriet og modenhedsmodeller for at understøtte indkøbsbeslutninger i bygherreorganisationer, herunder strategiske partnerskaber. Ph.d.-forskningen har også produceret arketyper for forretningsmodeller til at analysere friktion, når arkitekt-, ingeniør- og entreprenørvirksomheder (AEC) og producenter af byggematerialer indgår strategiske partnerskaber. På baggrund af de gennemførte litteraturgennemgange blev der lavet en taksonomi af relationelle kontrakter, der viser sammenhænge mellem strategiske partnerskaber og de etablerede relationelle kontrakttyper; Partnering, alliance og integreret projektlevering.

Arbejdet er relevant for praktikere, da det understøtter implementering af nye indkøbsstrategier, udvikling af organisatorisk modenhed og forretningsmodeller til at understøtte strategiske partnerskaber. En række af forskningens resultater og modeller har generel anvendelighed både i byggebranchen og i andre brancher. Resultaterne er også relevante for akademikere, der ønsker at udvikle definitioner for typer af relationelle kontrakter, modeller for organisationsændringer eller forske i forretningsmodelinnovation i byggebranchen.

## PREFACE

This PhD thesis is the conclusion of a PhD project at the department of Technology, Management and Economics at the Technical University of Denmark. The project title is “Radical improvements in sustainable building renovation based on new forms of collaboration and business models” and the two supervisors of the project were:

- Main supervisor, Christian Thuesen, Associate Professor at Department of Technology, Management and Economics
- Co-supervisor, Per Anker Jensen, Professor at Department of Technology, Management and Economics

The project has been supported by the Danish Innovation Foundation through the societal partnership REnovating BUildings Sustainably (REBUS). The societal partnership has participants from the entire construction value chain.

In the research there has been a focus on tools and models to support practitioners and academics in relations to strategic partnerships, organizational maturity and business models in the construction industry.

Lyngby, June 2022

Jakob Brinkø Berg, MSc Eng.

## ACKNOWLEDGEMENTS

An extraordinary large number of people have contributed to the PhD project of which this thesis is the final product. Firstly, my supervisors Christian Thuesen and Per Anker Jensen, who through coaching, inspirational conversations and great supervision have given the PhD project both theoretical depth and a practical focus. Secondly, the large team in Work Package 1 of the societal partnership REnovate BUildings Sustainably (REBUS) and especially Hans Blinkilde, chair of REBUS Work Package 1, who from the beginning gave this PhD project a very close connection to industry.

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In areas where my own background did not provide the necessary prerequisites for the scientific work, several research groups and individuals contributed to my education and improvement of the project. Specifically the Business Model Design Centre at Aalborg University as well as researchers from Copenhagen Business School provided a lot of insight into business models and research in companies without which the project would not have had such a nuanced perspective.

The research would not have been possible without the financial support from the Innovation foundation and I would also like to extend my warmest gratitude to other funding bodies, who support research in relational contracts in the Danish construction industry like Realdania.

I would also like to thank Centre for Facility Management, which has provided both practitioner feedback on my research and been a very positive environment to discuss building renovation and maintenance issues. My research group Engineering Systems Design headed by Anja Maier, have also in countless ways supported my research and been an inspiration to explore methodologies and areas of theory without which my projects would have been much poorer.

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Jakob Brinkø Berg, MSc. Eng.

Virum, June 2022

# LIST OF PUBLICATIONS

## **This thesis is based on the following publications:**

**Berg, J. B.**, Thuesen, C. and Jensen, P. A., (Berg et al. 2022a) *“Procurement innovation as a vehicle for sustainable change – a case study of the Danish model of strategic partnerships”*, Construction Innovation, vol. ahead-of-print, no. ahead-of-print, 2022.

**Berg, J. B.**, Thuesen, C. and Jensen, P. A., (Berg et al. 2022b) *“Understanding transactions: A maturity model for construction supply chain relationships”*, Submitted to Journal of purchasing and supply management

**Berg, J. B.**, Thuesen, C., Ernstsén, S. K., and Jensen, P. A., (Berg et al. 2021) *“Reconfiguring the construction value chain: Analysing key sources of friction in the business model archetypes of AEC companies in strategic partnerships”*, Published in Construction Management and Economics, Volume 39 Issue 6, 2021

## **Publications that were part of the PhD study but not part of the thesis:**

Jensen, P. A., **Berg, J. B.** and Thuesen, C., *“Prerequisites for Successful Strategic Partnerships for Sustainable Building Renovation”*, 9th Nordic Conference on Construction Economics and Organisation, Gothenburg, Sweden, 2017

**Berg, J. B.**, Jensen, P. A. and Thuesen, C., *“Maturity model for strategic collaboration in sustainable building renovation”*, Association of Researchers in Construction Management, ARCOM - 33rd Annual Conference, 2017

Ernstsén, S. K., Koch-Ørvad, N., **Berg, J. B.**, Brinck, S., Thuesen, C. and Maier, A. M., *“Learning from Digitalised Industries: Designing Value Propositions for Disruption”*, The ISPIM Innovation Conference – Innovation, The Name of The Game, Stockholm, Sweden, 2018

Jensen, P. A., Maslesa, E. and **Berg, J. B.**, *“Sustainable Building Renovation: Proposals for a Research Agenda”*, Sustainability (Switzerland), vol. 10, no. 12, 2018, doi:10.3390/su10124677

Jensen, P. A., Maslesa, E., **Berg, J. B.** and Thuesen, C., *“10 Questions Concerning Sustainable Building Renovation”* Building and Environment, vol. 143, Elsevier Ltd, 2018, pp. 130–137, doi:10.1016/j.buildenv.2018.06.051.

**Berg, J. B.**, Thuesen, C., Ernstsén, S. K. And Jensen, P. A., *“Constructing archetypes: mapping business models in the construction value chain”*, Association of Researchers in Construction Management, ARCOM – 35th Annual Conference, 2019



### **Other scientific publications during PhD study:**

Kong, W., Dannemand, M., **Berg, J. B.**, Fan, J., Englmaier, G., Dragsted, J., & Furbo, S., "*Experimental investigations on phase separation for different heights of sodium acetate water mixtures under different conditions*", Applied Thermal Engineering, 148, 796-805, 2019

Englmaier, G., Kong, W., **Berg, J. B.**, Furbo, S., & Fan, J., "*Demonstration of a solar combi-system utilizing stable supercooling of sodium acetate trihydrate for heat storage*", Applied Thermal Engineering, 2020

### **Publications for practitioners and industry:**

"Mindre værditab i renoveringsprocessen - potentialer ved strategiske partnerskaber", 2018, <http://rebus.nu/viden-og-vaerktoejer/>

Gottlieb, S. C., Thuesen, C., Frederiksen, N., & **Berg, J. B.** "Strategiske partnerskaber i Københavns Kommune: Erfaringer og resultater 2017-2019". Institut for Byggeri, By og Miljø (BUILD), Aalborg Universitet, 2020.

"Strategiske partnerskaber – Fra idé til kontrakt" REBUS & VærdiByg, 2021

"Strategiske partnerskaber – samarbejdets gennemførelse" REBUS & VærdiByg, 2021

### **Website:**

<https://strategiskpartnerskab.dk/>

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## LIST OF ABBREVIATIONS

ACE	Army Core of Engineers
AEC	Architecture, Engineering & Construction
AIA	American Institute of Architects
BMC	Business Model Canvas
BMDC	Business Model Design Centre
BREEAM	Building Research Establishment Environmental Assessment Method
CMM	Capability Maturity Model
CRINE	Cost Reduction: Initiative for the New Era
CSCT	Construction Supply Chain Transaction maturity model
DGNB	Deutsche Gesellschaft für Nachhaltiges Bauen
EU	European Union
EUR	Euro
FBBM	Four Block Business Model framework
fsb	Foreningen Socialt Boligbyggeri
GDP	Gross Domestic Product
IPD	Integrated Project Delivery
KA	Key Attributes
KAB	Københavns Almindelige Boligselskab
KPI	Key Performance Indicator
LCA	Life Cycle Assessment
LCC	Life Cycle Costing
MEAT	Most Economically Advantageous Tender
PPP	Public Private Partnerships
REBUS	REnovating BUildings Sustainably
SCR	Supply Chain Relationships in construction maturity model
TCE	Transaction Cost Economics
UK	United Kingdom
US	United States
WoS	Web of Science

# 1 INTRODUCTION AND MOTIVATION

This PhD thesis is the product of research efforts started in 2016 at the Technical University of Denmark. The main scientific contributions of the thesis are three scientific papers and a taxonomy of relational contracts. The topics of the first paper is procurement innovation and how to create and replicate strategic partnerships. The second paper develops a maturity model for building clients seeking to implement or assess the suitability of implementing new ways of procuring building services such as strategic partnerships. The third and final paper assesses the business models of companies in the construction value chain and the effect on their business models when entering into close collaboration in a strategic partnership. The taxonomy of relational contracts shows the connections between the three main relational contract types, Partnering, Alliancing and Integrated Project Delivery (IPD) and strategic partnerships.

The research presented in this PhD thesis was made as a part of a value chain wide effort to enable the Danish construction industry to make better sustainable renovation projects, become more efficient and improve the indoor climate in renovated buildings (TI, 2021, REBUS, 2021, Realdania, 2021). To focus this effort the societal partnership REnovating BUildings Sustainably (REBUS) was established with participants from across the construction value chain. A key aspect of enabling the construction value chain to reach the goals set out by REBUS was to create better collaboration between key stakeholders. Strategic partnership is a procurement practice that supports this collaboration, but is a radical departure from traditional relationships in the construction industry (Eriksson, 2010, Lahdenperä, 2012, Mouzas & Blois, 2015, Jensen et al., 2017, Jensen et al., 2018b). The goal of the research is to provide knowledge of how actors in the construction value chain react to the relational contracting practice of strategic partnerships.

In the following section the motivation behind the PhD research presented including practical and theoretical context of the research. It shows why the construction industry is important to society and why sustainability and renovation are necessary, while creating new challenges for the construction industry.

## 1.1 MOTIVATION

The world needs sustainable buildings. This statement is tautological since un-sustainable systems on a long timescale are doomed to failure. A central challenge is that society has already produced a vast number of buildings at great expense and with great intrinsic value (Wells, 1985). To keep this intrinsic value and preserve the initial societal investment the answer must be to renovate existing buildings to meet the standards of the 21<sup>st</sup> century (European Commission, 2020). Since the energy crisis of the 1970'ies great efforts have been made to determine how to make the existing building stock better and more efficient (Ástmarsson et al., 2013, D'Agostino et al., 2017, Thomsen et al., 2016). The need for energy efficiency have not decreased and in 2022 a new energy crisis may be looming on the horizon (European Commission, 2022). Unfortunately renovations does not always yield satisfying results, and with an increasing number of sustainability demands, the task of renovating sustainably becomes more complex and difficult (Jensen et al., 2018a).

It may be tempting to look for a technological solution to the problem and many have been developed. From energy efficient windows, mechanical ventilation to insulation and intelligent building management systems they all offer a piece of the energy and/or indoor climate solution. But to make a sustainable renovation all aspects of the building process have to be accounted

for because our understanding of sustainability is broader than energy or material use (Yılmaz & Bakış, 2015). Given that the hurdles do not lie in the laws of physics or in technological limitations in our production and manufacturing infrastructure, the challenges must be found in the management of resources and people. These resources and people have been formed by traditions and institutions spanning centuries if not millennia.

The construction industry have been characterized as being very conservative and lacking in innovation (Dubois & Gadde, 2002). The reason given for this has been the fragmented nature of the building industry, and to solve this several initiatives have been launched to make the construction industry better at collaboration (Spaven, 1993, Latham, 1994, Egan, 1998, Ross, 1999, Zaghoul & Hartman, 2003). To understand why so much effort have been put into create better processes it is important to appreciate the history, size and importance of the construction industry.

The construction industry literally pre-dates written history (Dietrich et al., 2012). In many ways, this shows how central construction has always been to human civilization and still is in modern society. The seven classical wonders of the world were all built, they were wonders created by civilizations expressed using buildings. It is with this in mind that the reality of the construction process is in stark contrast. No matter how much buildings and monuments are treasured, the construction process has for as long as there have been records been a cause for concern. In one of the first codes of law that has survived to modern day, the "Code of Hammurabi" from 1800 BC, this concern can be found (Yoffee, 2005). The "Code of Hammurabi" is from Mesopotamia, and six laws deal directly with construction issues.

The first those six, law no. 228, deals with payment and the remaining five laws deals with punishment of the contractor. An example is law no. 229.

*"If a builder build a house for someone, and does not construct it properly, and the house which he built fall in and kill its owner, then that builder shall be put to death." – Law no. 229  
(Hammurabi [1780 BCE] & King, 1915)*

In modern construction, we do fortunately not have capital punishment anymore, but this is an example that shows how fundamental to civilization construction is and how old the mind-set of punishing contractors is. Today this mind-set of punishment is very much still a prevalent force in the modern construction industry (Bresnen & Marshall, 2000).

Over the millennia, the construction industry has not diminished in importance. As an example, the construction industry is today responsible for more than 6% of the total GDP in Denmark, Sweden and UK as can be seen in Figure 1. As an industry, construction is important in terms of employment and the employment in construction is expected to grow in the near future by 5.6% in Denmark and Sweden and 0,5% in the UK (ECSO, 2019a, ECSO, 2019b, ECSO, 2019c). Construction also plays a vital part in creating wealth for a country through the value the current building stock represents. In 2018 the asset value of buildings in Denmark, Sweden and UK was 597, 1040 and 3044 billion EUR, respectively (ECSO, 2019a, ECSO, 2019b, ECSO, 2019c), and has steadily increased in the last decade as can be seen in Figure 2Figure 1. This also highlights the necessity of maintaining the building stock to ensure that it retains or increases in asset value. All of this economic activity means that even a small improvement in output can have a tremendous impact.



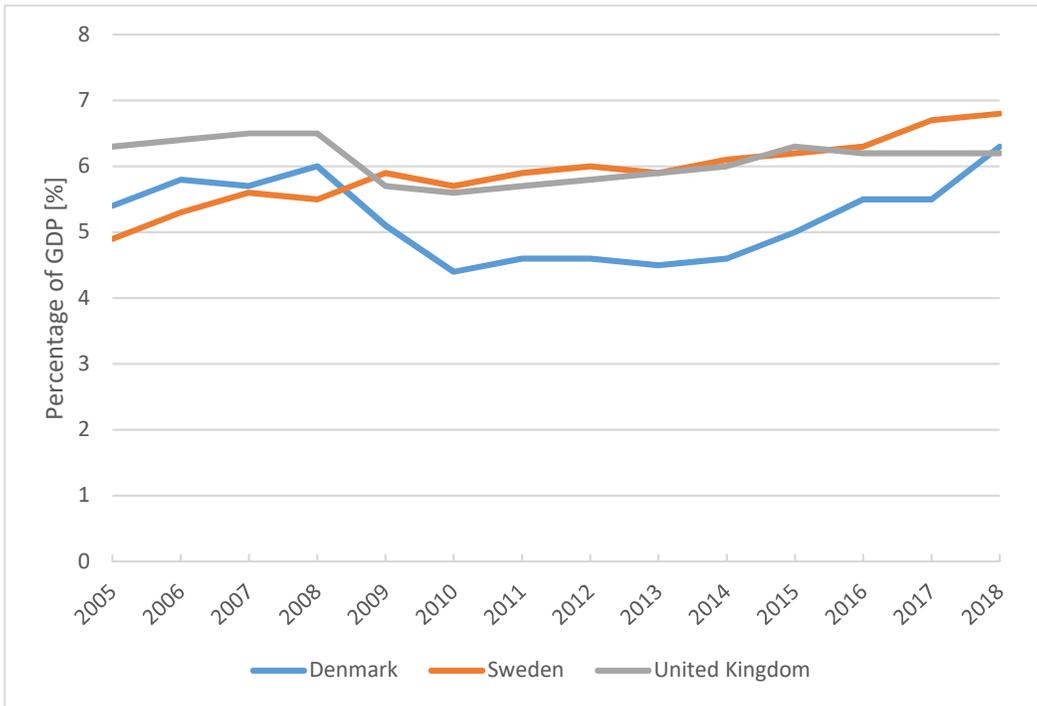


Figure 1 Share of construction in GDP of Denmark, Sweden and United Kingdom (UNECE, 2020)

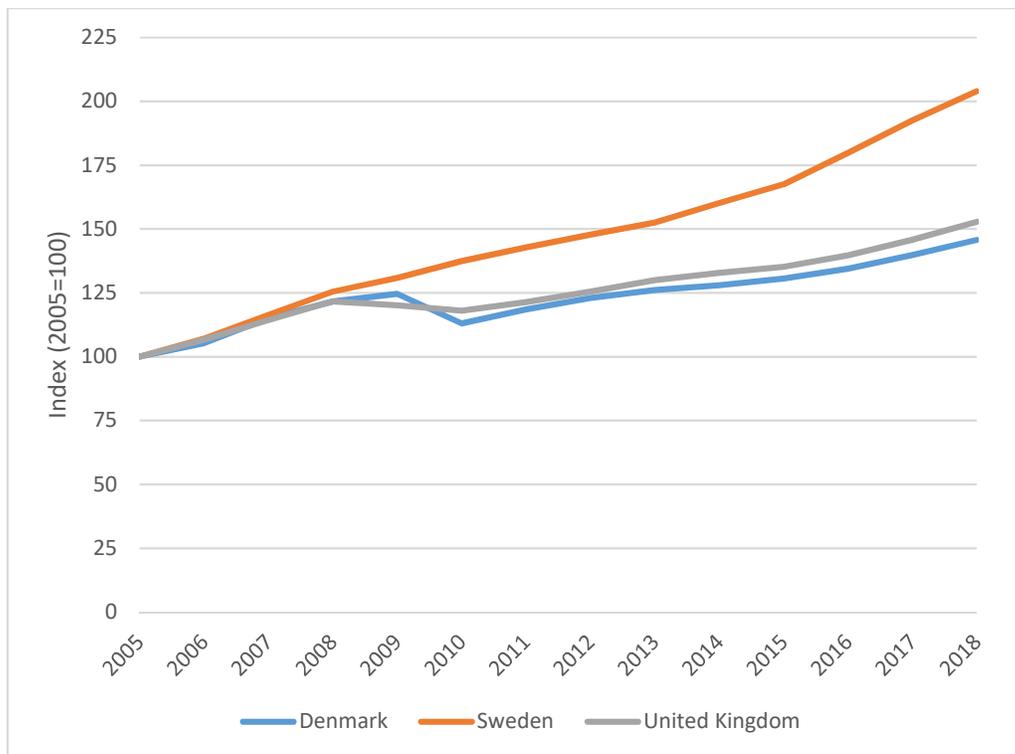


Figure 2 National asset value of buildings in Denmark, Sweden and UK, (Index: 2005 = 100)  
 source: Statistikmyndigheten, Danmarks statistik and Office for National Statistics

As shown above the construction industry is a very important in terms of creating value, jobs and wealth in society. The construction industry is also challenged by new boundary conditions and this will be examined in more details in the following sections. The first section on the practical context of the research outlines three key themes; need for sustainability, need for renovation and increased project complexity. To understand the practical context, a theoretical context section subsequently details which frameworks and fields of research have been used. Figure 3 shows the connection between the practical context themes and the theoretical context.

The added complexity by the need for sustainability and the already inherent complexity of renovation projects creates complex building projects. When a product or service changes in complexity, in this case building projects becoming more complex, Transaction Cost Economics is a framework that can be used to assess an appropriate governance type. The governance type for complex or idiosyncratic products is relational contracts. Relational contracts in turn leads to new demands such as building client maturity, change in AEC business models and procurement innovation.

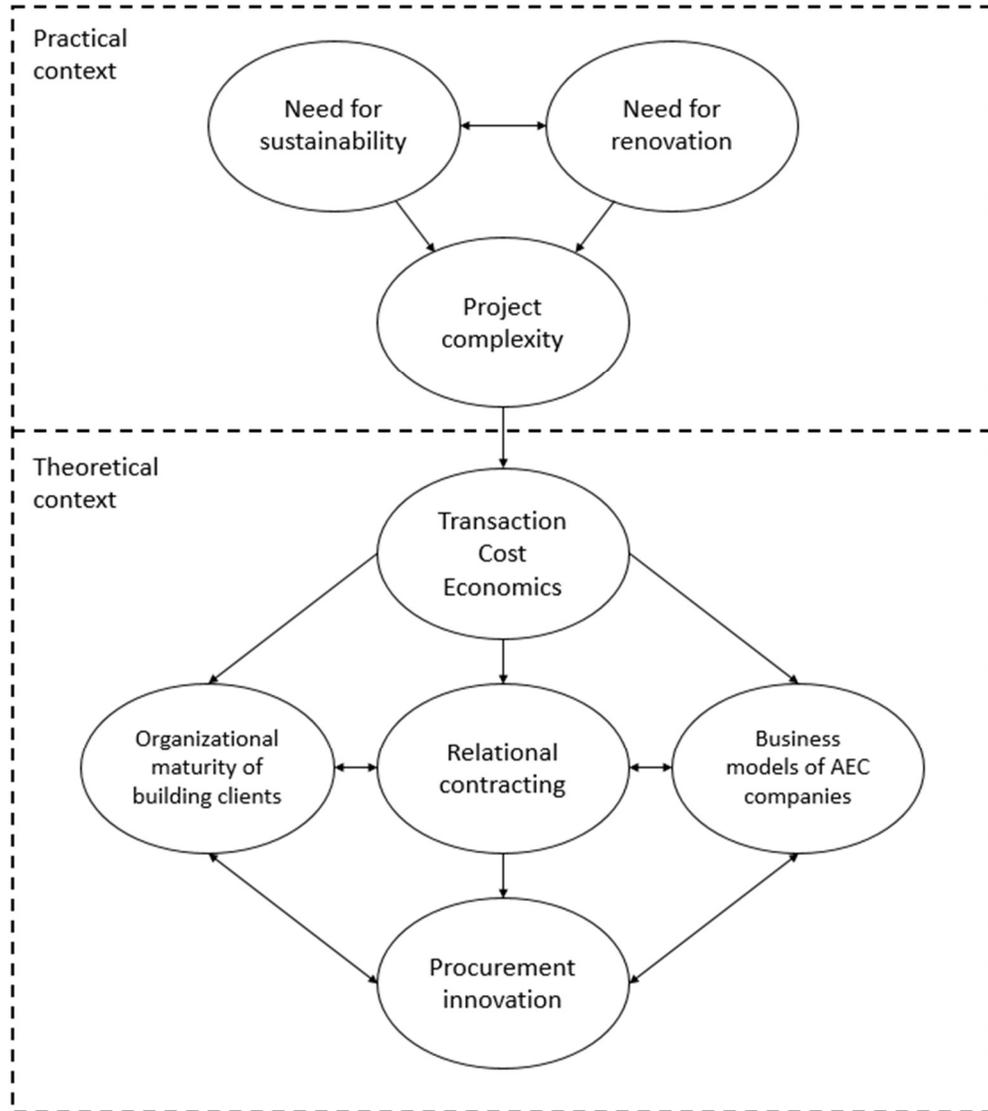


Figure 3 Connections for the practical context themes and the theoretical context of the PhD thesis

## 1.2 PRACTICAL CONTEXT

The research presented in this thesis has, as all research with a practitioner component, a practical context. This context shapes the direction of the industry and determines which avenues of research are viable. Relevant for this research are three central practical context themes as shown in Figure 3:

- Sustainability
- The need for renovation
- Increase of project complexity

## Sustainability

The sustainability agenda has been driven by climate change, deteriorating ecosystems and limitations in resource availability. This has forced every sector, including the construction industry, to change behaviour (Brundtland, 1988, IPCC, 2021). In almost every industry sustainability has become a very strong driver and starting in the late 1980's international organizations and governments have deemed sustainability one of the most important subjects (Brundtland, 1987; IPCC, 2021; United Nations, 2015; Valdes-Vasquez & Klotz, 2013; Yilmaz & Bakış, 2015). The focus on sustainability has had three main areas; economic, environmental and social sustainability (UNCSD, 2012). This focus is not only used by state actors but Life Cycle Assessments (LCA) and environmental impact reports are becoming tools for benchmarking products and company performance (Norman & Macdonald, 2003). Both in terms of economic sustainability and environmental sustainability the construction industry plays a pivotal role and societal economy is in many ways impacted by the productivity and value creation in the construction industry.

Buildings need to consume less resources, while at the same time improve quality of life, and provide reasonably priced homes (D'Agostino et al., 2017, Jensen et al., 2018a, Nielsen et al., 2016, Kalamees et al., 2017, Johansen et al., 2017). In terms of environmental impact the creation of building materials, transportation and direct energy consumption in buildings requires large amounts of resources (Morel et al., 2001, Markarian, 2016). This together with the waste from building sites and demolition this means that the construction industry has to be cognisant of its responsibility to recycle and reuse (Katz & Baum, 2011). It is a challenge the construction industry is struggling to meet, and where a new approach will help, not only the construction industry but also help improving living conditions and society as a whole (Kwawu & Hughes, 2005, Latham, 1994, Levitt et al., 2012, Bygballe et al., 2010).

While the economic and environmental sustainability has been in focus for some time, there is a growing realization that social sustainability should also be a core part of governmental and private investment strategies (Sciulli, 2011, Szczuka, 2015). Social sustainability does however suffer from a lack of rigorous definition and it has been suggested that there is a need for a more rigorous approach (Larsen & Jensen, 2019, Jensen et al., 2018a). The built environment is an important component of social sustainability since it should support the activities of the inhabitants and inspire to contemplation, activity and community in and around them (Gehl, 2004). While the goal of improving current conditions and securing a future where equal or better opportunities are afforded, is simple to state, it is much harder to rigorously define sustainability (Howarth, 1997, Carew & Mitchell, 2008). The two categories of economic and environmental sustainability have been sought to be defined by a single tool, Life Cycle Costing (LCC) and Life Cycle Assessment (LCA) respectively. On the third, the social category, this has been covered only in part by a multitude of tools in a building context. Building certification schemes like BREEAM or DGNB have health and safety as part of their evaluation criteria, covering the occupants and practitioners in the construction value chain.

In the case of social housing, economic sustainability is also linked to the social sustainability agenda. When renovating social housing it is self-evident that it should not price out the middle and low income households, which these dwellings were originally intended for. Social housing is also government supported in countries like Denmark and as such there is a civic duty to make sure that value is created for society through renovating them. With the large amount of

funding for sustainable renovation of social housing there is an opportunity for the construction industry to make a large impact (Grøn Boligaftale, 2020).

### **The need for renovation**

To create diverse cities, which do not only cater to the highest bidder, national and local governments have created a number of initiatives to keep housing prices low or at least reasonable (Clark & Heskin, 1982, Priemus & Dieleman, 2002). Rent control, building coops and social housing are some of the techniques used in Danish cities (Boligreguleringsloven, 2019, Almenboligloven, 2019, Andelsboligloven, 2018, H. G. Larsen & Lund Hansen, 2015). Denmark is the country with the second highest relative amount of social housing only trailing Holland (Priemus & Dieleman, 2002). The reason for 19% of residents in Denmark today living in social housing can be found in a 1960'ies social housing building boom (Vestergaard & Scanlon, 2014). This building boom also influences the average building age of the social housing building stock that today is on average 44 years old. Since the buildings have been occupied for so long means there is a general need for renovation of these buildings (Landsbyggefonden, 2019). The emphasis on sustainability in this renovation is backed by a strong political support for this renovation to have a focus on sustainability (Grøn Boligaftale, 2020).

With regard to the need for renovation, the second practical context theme, the immediate need for large parts of the building stock to be renovated, is in large parts a European centric issue. The need for renovation comes from previous building booms, strict regulation of urban areas and the general long lifespans of buildings in European countries (Artola et al., 2016). To make the current building stock live up to modern sustainability standards they need to be renovated and in this way renovation is a means to achieve sustainability. Renovating residential buildings is however not a simple task (Nielsen et al., 2016, Thuvander et al., 2012). The nature of the existing building and the techniques used in the original construction play a part (Mata & Johnsson, 2017, Ascione et al., 2017). The current residents and users, who in some cases remain in the building during renovation, are the most obvious challenge as they are impacted directly in several ways (Stocker & Koch, 2017, Ástmarsson et al., 2013). Then there are local stakeholders, the municipal government, planning departments and a number of others, who in some way are affected by the renovation project (Kamari et al., 2019). The building site can be in a dense urban area, where heavy traffic, vibration or dust will have a direct impact on the surrounding buildings and people. All of these factors combined make it very difficult to succeed on every parameter with a renovation project.

### **Increase of project complexity**

The third practical context theme, increase of project complexity, is a consequence of the first two. Because of sustainability demands and the need for renovation, projects involve complex processes and have multifaceted goal structures (Jensen et al., 2018a). A sustainability agenda can follow several targets, like energy use per square meter floor area, have focus on using non air polluting building site machinery or increase the use of unskilled or marginalized people in the work force. In a renovation project where the use, physical structure or interior of the building is substantially altered these extra goals makes the project much more difficult to execute (Thuvander et al., 2012). This leads to building clients being unhappy with the perceived price to performance of the renovation projects using traditional procurement practices (Wong et al., 1999). The traditional procurement practices do not seem to be suited to

facilitate building projects where there is the need to balance multiple goals and there is a large degree of uncertainty of the final product.

In a sustainable renovation, the construction project in itself also poses challenges (Nielsen et al., 2016). The current state of the building, material degradation, load-bearing structure, roof and façade elements have to be taken into account. With a renovation aiming at decreasing the energy use of the building, heating, cooling and ventilation systems have to be replaced, and the entire energy balance of the building needs to be updated (D'Agostino et al., 2017). Considering the myriad of processes and components involved, sustainable renovation requires a large number of capabilities in building assessment, design, construction and commissioning.

The embodied energy in the existing building materials can be substantial and by renovating existing buildings this saves the energy of producing a replacement (Thormark, 2002). A renovation project with the main focus on energy efficiency can provide additional benefits, which are often under reported (Thomsen et al., 2016). These could be on the building level with increased comfort or a longer life span of the building. It also manifests itself in society as increased economic activity, less overall energy demand and better health outcomes for the residents (Artola et al., 2016). It is therefore important to have the right prerequisites in order to have a successful sustainable building renovation project (Jensen et al., 2017).

Apart from the general global trends shaping the construction industry there also is a number of local factors that enabled the PhD research to take place. An important local factor was the creation of a societal partnership and development initiative REBUS with funding from Innovation Fund Denmark. This partnership had participants from the entire construction value chain; architects, consultant engineers, contractors, building material suppliers, building clients and knowledge institutions. On top of funding the research it also provided easy access to the companies and organisations participating, creating data collection opportunities. At the same time as the PhD project started another local development in the construction industry made the research possible. The first two strategic partnerships in Denmark were tendered in 2016 and this enabled the study of the procurement scheme in full scale (ByK, 2016). This natural experiment was followed by several other strategic partnerships from other public building clients such as social housing organisations.

To understand the phenomena in the practical context a number of theoretical frameworks were identified. This created the theoretical context for the study.

### 1.3 THEORETICAL CONTEXT

To make sense of the practical context and the empirical data five theoretical frameworks were chosen for the study, as shown in Figure 3.

- Transaction Cost Economics
- Relational contracting
- Procurement innovation
- Maturity models
- Business models

#### **Transaction Cost Economics**

Given the practical context of sustainable building renovation leading to dissatisfactory results due to increase in complexity when using traditional procurement methods, what alternatives

are there? To look at relationships between companies and organisations the preeminent theoretical framework has for the last four decades been Transaction Costs Economics (TCE) (Hardt, 2009). The use of TCE analysis can show how the transaction relationship between entities should change based on the nature of the product (Williamson, 1979). Since the nature of renovation projects have changed with sustainable renovation it stands to reason that the relationship between building client and Architecture, Engineering and Construction (AEC) companies should be examined to see if an alternative approach is more suitable than traditional market contracts. One of these alternatives to traditional market contracts are relational contracts, which are substantially different from traditional procurement methods (Colledge, 2005). To appreciate these differences it is important to have a clear picture of what constitutes a traditional contract and the importance of contracts in the construction industry and how TCE analysis can bring new perspectives.

Contracts in the building industry have in one form or another been part of the construction process for hundreds of years (Thomas, 1993, Broome & Hayes, 1997). A contract is in place if two or more parties intend to be legally bound and have reached a sufficient agreement (EU, 2002). It is a way to assign responsibility and entitlements to parties, who wish to exchange something. This could be time, work, goods, land or anything else that can be assigned value. It is remarkable that the contracts, for all their importance to the construction process, do not get more attention (Surahyo, 2018). Of course, a contract does not contribute a single brick or engineering calculation, but it does set out the incentive structure, which in the end will have a great impact on whether the participants reach a suboptimal or an optimal result (Klee, 2018). The traditional view of contracts has been that they are discrete and that a transaction can be viewed as separated from the preceding and following events (Macnil, 1974). This is not assumed in TCE and at its core TCE only has two assumptions, the first being that it is not possible for an actor to have perfect information in a transaction, also called “bounded rationality”. This means that they are rational but only so far their knowledge of the situation allows them. The second is that *some* actors are opportunistic (Williamson, 1981). A key condition for TCE analysis to make sense is some amount of uncertainty in the outcome of the transaction. If all parameters can be described and understood by all parties any governance structure can be used.

The analysis method developed by Williamson (1979) used the frequency of the transaction and investment type to evaluate suitable contracting and governance types. The frequency of transaction is how often two or more parties make a specific type of transaction. The nature of the investment or investment type is the investment necessary to facilitate the transaction. Williamson (1979) gives an example of a type of good, which needed a governance structure other than a classical market structure. In the example “Constructing a Plant” is a transaction which needs a more elaborate governance structure. Construction apparently, in the view of TCE, does in some cases warrant a more elaborate governance structure. In the analysis there are three governance categories; classical (market), neo-classical and relational contracting. Classical market contracts are made with simple evaluation criteria such as price. In the neo-classical contract there are additional elements of governance like third party dispute resolution and renegotiation. The third contracting type, relational contracting, is applicable for idiosyncratic and recurrent transactions, like renovating a portfolio of building projects.

In a TCE analysis of a transaction there are three major factors; uncertainty, transaction frequency and investment characteristics (Williamson, 1979). Relational contracts are suitable, if

uncertainty is present, if the transaction is recurring, and if the investments are highly idiosyncratic or specialized. Thus for renovation projects in a project portfolio, relational contracts seem to be a perfect match.

### **Relational contracting**

In a relational contract, there is a fundamental logic shift from a traditional or market contract relationship. In a market contract, the allocation of the contract is in essence arbitrary. The supplier is expected to adhere to the terms of the contract and nothing more. This type of relationship insulates the buyer from the underperformance of a supplier by making it easy to get compensation and replace such a supplier. In a market contract it is implicitly assumed that switching supplier is associated with negligible cost. However, in cases where the switching costs are very high, this compensation and replacement of a supplier might not be possible. In this type of cases, a relational contract relationship will be more appropriate. In relational contracts, the choice of suppliers is everything but arbitrary. It is in the selection process that the buyer builds the trust and confidence in the supplier, which will create the basis of the subsequent interactions (Petersen & Østergaard, 2018).

The relational contract is in essence a self-enforcing contract, since at its core the relational contract employs common incentive schemes, which makes it more attractive to the participants to honour the contract than not honouring it (Halac, 2012). Relational contracts have been coupled with TCE by other researchers when it relates to construction transactions (Colledge, 2005). As one of the main areas of focus for this thesis is strategic partnerships, which is a relational contracting scheme, understanding what the strengths and weaknesses in this type of procurement scheme are, is essential. Relational contracts focus on the creation of teams and bilateral governance of projects where both client and the companies collaborate in the decision making process (Brown et al., 2004). This type of contract is suitable to projects that have multiple goals and where there is a certain amount of outcome uncertainty (Goetz & Scott, 1981). In the construction industry a number of relational contract types has been developed like Integrated Project Delivery (IPD), Alliancing and Partnering (Lahdenperä, 2012). One of the newest forms of relational contracts are Strategic Partnerships, which is relevant for building clients with portfolios of building or renovation projects (Berg, Thuesen, & Jensen, 2022a). Gottlieb et al. (2020a) examines these Strategic Partnerships and conclude that they are not static entities and can be viewed as “trading zones”. Over time the “trading zone” will develop in different directions depending on the participants. This procurement innovations requires the development of new capabilities by the organizations in the construction value chain.

### **Procurement innovation**

The field of procurement innovation has received increased attention from the scientific community since 2008 (Kundu, James, & Rigby, 2020). It is a very broad field of study and comprises both public and private procurement within a large number of industries. One of the key challenges in procurement innovation is repeatability, and how to transition from single experiments to a fully established new form of procurement (Plantinga, Voordijk, & Dorée, 2020). A key to understand the difficulty of establishing a new form of procurement is the perceived rigidity of the regulatory framework namely around public procurement (Uyarra et al., 2014). It is important to distinguish between “procurement of innovation”, “procurement for innovation” and the act of innovating procurement practices. Most of the literature focuses on the first two while in the context of this PhD thesis it is the latter kind that is in focus (Kundu et



al., 2020). This type of research can for instance be found relating to the introduction of Public Private Partnerships (PPP) in circular economy for construction waste (Bao, Lu, Chi, Yuan, & Hao, 2019). Plantinga et al., (2020) has developed a method to implement innovative procurement practices in public organisations with a project portfolio. In the field of Facility Management, Jensen (2011) studies innovative procurement practices by a public building owner and a private pharmaceutical company.

The research shows that procurement innovation can be an important tool to achieve new goals and objectives, but it comes with inherent challenges in implementation and it is important to use procurement strategies appropriately.

### Maturity models

When engaging in different procurement methods, this requires new capabilities and in some cases more mature processes for the building client. To evaluate maturity of organisations and processes maturity models were selected as a framework for the PhD research. Maturity models were invented in the 1990's to gage the process maturity of suppliers of software (Paulk et al., 1993). Public procurement of complex products such as IT systems needed a way to assess the process maturity of a supplier and thus the likelihood of project success. The Capability Maturity Model (CMM) was created to score potential suppliers on a maturity scale with five levels; Initial, Repeatable, Defined, Managed and Optimized, see Figure 4. Each level had a "Behavioural Characterization" describing the typical mode of operation of a supplier at that maturity level.

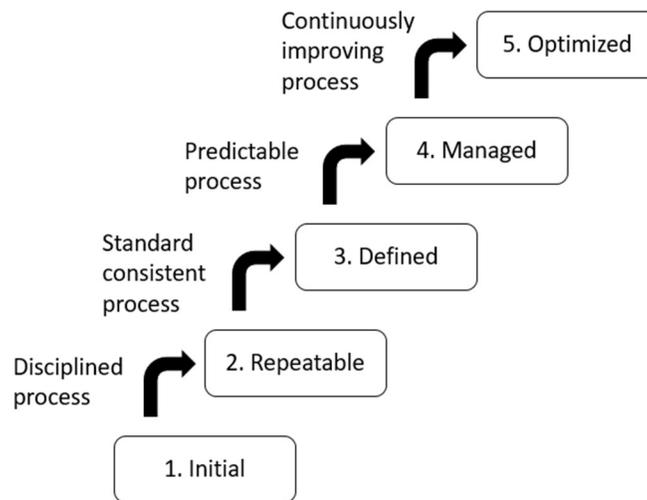


Figure 4 CMM - Five levels of software process maturity from Paulk et al., (1993)

Maturity models were further developed and subsequently used in many industries to gage process maturity (Wendler, 2012). It developed a distinct form in two parts; a graphical level description and a Key Attribute (KA) or Key Performance Indicator (KPI) matrix. The graphical level description is also present in the original CMM but can take the form of steps or levels in a Cartesian coordinate system with an x- and y-axis. Instead of "Behavioural Characterization" describing each level, the KA or KPI matrix is used in most modern maturity models.

In the development of maturity models there are also two distinct view points on maturity progression: a life cycle perspective and a potential performance perspective (Wendler, 2012). In a life cycle perspective an organisation becomes more mature in its processes as it works more with them. This is the view in the CCM. What starts out as an “Ad hoc” process will over time progress and rise to a higher maturity level. The potential performance perspective takes the view that processes should have an appropriate maturity level. A maturity level should only be increased if there is a potential performance benefit in doing so. Changing maturity level of a process is a conscious choice and should be analysed and deliberately chosen. With the foundation of TCE and that relationships should be made using deliberate analysis, the maturity model developed as part of the PhD research has a potential performance perspective. This perspective enables an analysis of both the value but also the inherent complexity associated with an increase in maturity of the relationship between a building client and AEC companies.

### **Business models**

Since relational contracts in general, and strategic partnerships specifically, change the way companies and organisations interact, it becomes an interesting research subject to identify in what way they change. To get an understanding of how a company operates and how such operations change due to relational contracts, business model frameworks is very useful (Sierotowicz, 2018). Business models and relational contracts are both connected to TCE. Part of what a business model frameworks seeks is to delineate the interfaces between the company and its environment (Osterwalder et al., 2010). That being for example the suppliers or sales channels. One of the goals of some business model analysis efforts is to identify areas where transaction costs can be reduced in order for the company to capture more value or provide superior value to a customer segment. Changing business models is however not a trivial thing and the close interaction of different business models in a strategic partnership may also lead to conflicts (Kim & Min, 2015). The economic term “friction” was used to analyse these internal and external challenges in changing business models. Friction is also connected to TCE since TCE analysis identifies a specific type of friction.

From the practical context described in section 1.2 and the above described theoretical context the PhD research is driven by a clear scientific purpose.

## **1.4 PURPOSE STATEMENT**

With the added complexity from increased focus on sustainability and the need for renovation, one of the responses to this challenge has been to introduce strategic partnerships as a new way of procuring and collaborating in renovation projects. The research presented in this PhD thesis uses the theoretical frameworks of TCE to understand this change to a relational contract type. Furthermore to understand this procurement innovation, maturity models and business models are used to understand the impact on building clients and AEC companies. The thesis also seeks to place strategic partnerships in the context of other established relational contract types.

In the PhD research the purpose was to investigate the change in relationships between the actors in the construction value chain when they engage in strategic partnerships. It is important to understand what these changes mean for the companies and the building clients in order to successfully use this type of relational contract.

Not only should the outcome of the research uncover the changes but also create tools for academics and practitioners.

## 1.5 READING GUIDE

The thesis is based on three scientific papers and the full context of the specific investigations can be found when reading these, as the papers are independent and self-contained. The result of the procurement innovation, maturity model and business model research are presented in detail in the papers and summarized in section 6.1-3.

This thesis is on the other hand focused on providing a coherent overview of the scientific work conducted in the course of making this PhD project and how it relates to the field of relational contracts in construction. Relational contract types are identified and strategic partnerships are put into the context of the relational contract family tree in section 6.4. Since theoretical concepts and the philosophical approach are similar in the research, it is described in depth in the thesis in a way that it is not possible in a scientific paper.

If the reader therefore is interested in a specific area of the research, the papers will be the best way to learn about and understand the results and application of the research. If on the other hand the reader wishes to understand the theoretical and philosophical justifications, together with a cohesive narrative describing the research of the PhD project together with the relative position with regard to the field of relational contracts in construction, this thesis is the most relevant.

Reading the thesis and the papers together will give the full understanding of all aspects of the work.

## 2 LITERATURE REVIEW

As part of the research effort four main literature reviews have been conducted. The focus of the first literature review is a scoping review of the field of relational contracts in construction presented in section 2.1, in order to create suitable definitions of the main relational contract types. In this search the main types of relational contracts are identified in section 2.1.1. Each of these types of relational contracts are subsequently defined using separate reviews as part of the first literature review and presented in section 2.1.2, 2.1.3 and 2.1.4. The way of defining relational contracts follows similar work by Lahdenperä (2012). This work to define established relational contract types is important when evaluation and contrasting new relational contract types such as strategic partnerships.

The other three literature reviews were systematic literature reviews and support the development of the three papers that are part of this PhD thesis. The first review being procurement innovation and in particular strategic partnerships. The second review is developing a suitable model for determining when and how to implement strategic partnerships. The third review aimed to describe the business models in the construction industry. In the three systematic literature reviews the search was focused on two main points; catalogue knowledge of prior work and to identify relevant research gaps.

### 2.1 RELATIONAL CONTRACTS IN CONSTRUCTION

A central theme in the theoretical context for the PhD research is relational contracts. Therefore a literature search of relational contracts in construction have been performed to establish which contract types in construction fall under the category of relational contracts. The scoping literature review was performed using the scientific search engine Web of Science (WoS) in April and May of 2022 and analysed using the scientific analysis tool VOSviewer.

#### 2.1.1 IDENTIFYING MAIN TYPES OF RELATIONAL CONTRACTS

Relational contracts are used in many fields and the two words “Relational” and “contract” are used in many fields. Adding an asterisk on “contract” enables results such as “contracts” and “contracting”. This results in a broader range of search results. To decrease the number of results the quotation mark is used to specifically search for tests with these two words in that specific order. To further specify that the papers should be related to construction “AEC” and “construction” was added to the search string.

As Table 1 shows the final search string resulted in 113 relevant results. The analysis will be conducted using these.

*Table 1 Search term iteration for relational contracts*

Search string	Results
Relational contract	2635
Relational contract*	3051
“Relational contract*”	821
“Relational contract*” AND (AEC OR construction)	113

Relational contracts in construction have been of general increasing interest since 2001. Although 2009 seems like is a peak year this is only due to the individual chapters of the book

“Relational Contracting for Construction Excellence: Principles, Practices and Case Studies” are counted as separate entries. The general trend is increasing year over year to 2021 as can be seen in Figure 5.

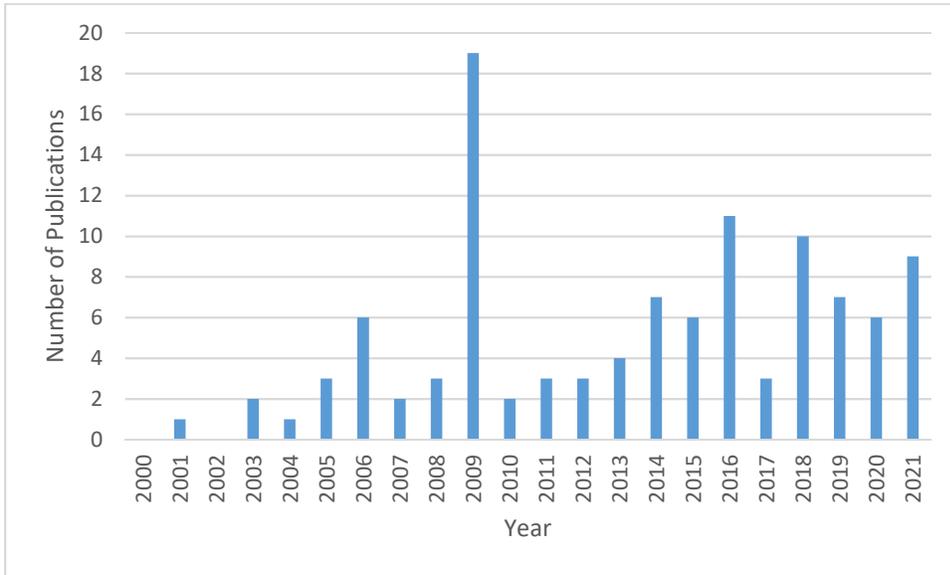


Figure 5 Number of publications with the subject of relational contracts in construction

To analyse the bibliographic coupling between the papers in the search results the program VOSviewer is used. The network can be seen in Figure 6 and shows the links of 93 items with sufficient bibliographic data to be used in the analysis.

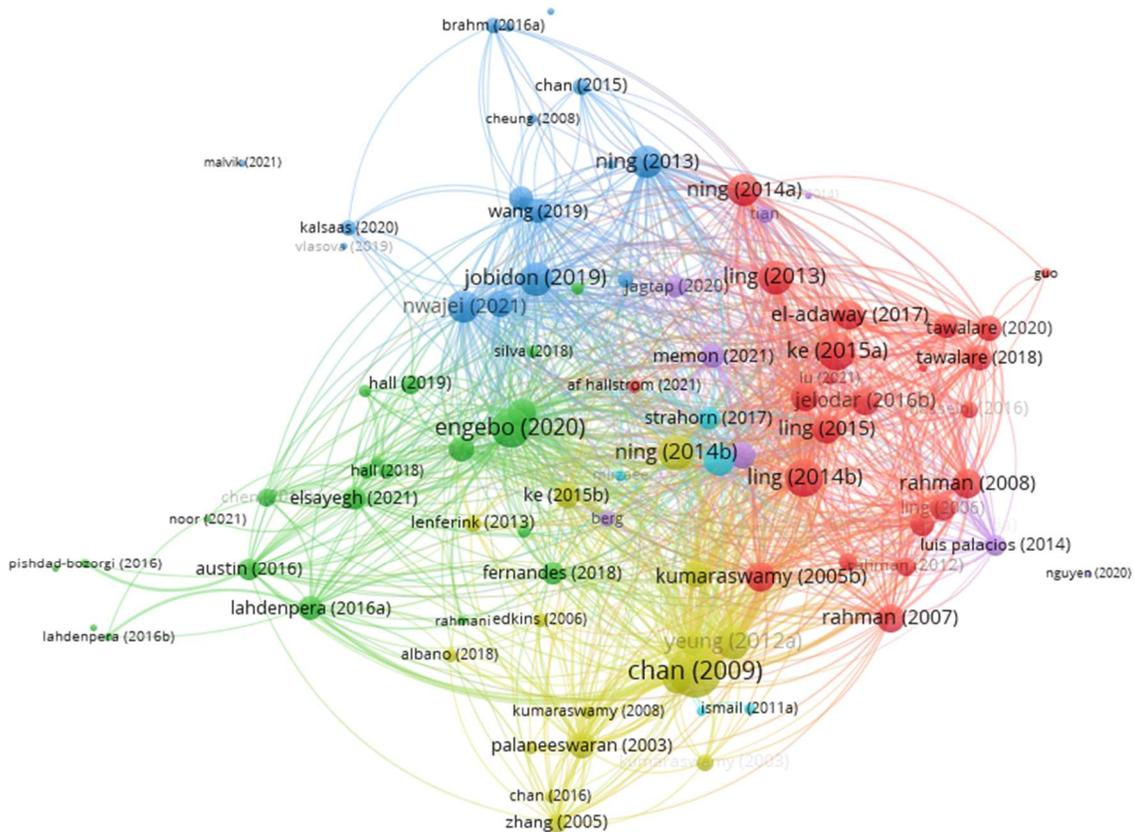


Figure 6 Network visualization using VOSviewer to show bibliographic coupling of the documents in the search results on relational contracts in construction

The overall bibliographic coupling analysis show a cohesive field of research. A few broadly cited articles like Zhang (2005) describing how relational contracts could be useful if implemented in Public Private Partnerships (PPP) and Lenferink et al. (2013) advocating for several different types of relational contracts which should be considered as an alternative to neo-classical contracts, see section 1.3.

Using the bibliographic coupling analysis tool in VOSviewer the most strongly coupled documents are identified in the search. These papers or books show the most and strongest coupling to the other research literature and as such will be literature reviews, key cited sources and other key resources in the field. For each of these documents the types of relational contracts identified are listed in Table 2. From the ten strongest coupled documents the types of relational contracts described in them are determined. This is done in order to find the most generally agreed upon types of relational contracts.

Table 2 The ten strongest coupled documents in the literature search and the relational contracts identified

Reference	Strength	Relational contract types identified
Relational Contracting for Construction Excellence: Principles, Practices and Case Studies (Chan, Chan, & Yeung, 2009)	943	<ul style="list-style-type: none"> <li>• Partnering</li> <li>• Strategic partnering</li> <li>• Project alliancing</li> <li>• Strategic alliancing</li> <li>• Public-private partnerships (PPP)</li> <li>• Joint venture</li> </ul>
Collaborative project delivery methods: A scoping review (Engebø et al., 2020)	534	<ul style="list-style-type: none"> <li>• Project Partnering</li> <li>• Strategic Partnering</li> <li>• Integrated Project Delivery</li> <li>• Project Alliancing</li> <li>• Strategic Alliancing</li> <li>• Early Contractor Involvement</li> <li>• Collaborative Procurement</li> <li>• Competitive Dialog</li> <li>• BOOT/PFI/PPP</li> </ul>
Key Relational Contracting Practices Affecting the Performance of Public Construction Projects in China (F. Y. Y. Ling, Ke, Kumaraswamy, & Wang, 2014)	483	<ul style="list-style-type: none"> <li>• Partnering</li> <li>• Alliancing</li> <li>• Joint venturing</li> <li>• Long-term contracting</li> <li>• Joint risk-sharing mechanisms</li> <li>• Integrated project delivery</li> </ul>
Effects of Contract Strategy on Interpersonal Relations and Project Outcomes of Public-Sector Construction Contracts in Australia (Ke, Ling, & Zou, 2015)	477	<ul style="list-style-type: none"> <li>• Partnering</li> <li>• Alliancing</li> <li>• Joint venturing</li> <li>• Long-term contracting</li> <li>• Joint risk-sharing mechanisms</li> <li>• Integrated project delivery</li> </ul>
Driving forces behind and barriers to relational transaction practices in public construction projects (Ning, Ling, & Teo, 2014)	419	<ul style="list-style-type: none"> <li>• Partnering</li> <li>• Alliancing</li> </ul>
Modeling relational transaction and relationship quality among team members in public projects in Hong Kong (Florence Y.Y. Ling, Ning, Ke, & Kumaraswamy, 2013)	393	No contract types identified
Comparison of Quebec's Project Delivery Methods Relational Contract Law and Differences in Contractual Language (Jobidon, Lemieux, & Bearegard, 2019)	386	<ul style="list-style-type: none"> <li>• Joint Venture</li> <li>• Partnering</li> <li>• Alliancing</li> <li>• Design-Build</li> <li>• IPD</li> <li>• PPP</li> <li>• Construction Manager At Risk</li> <li>• Construction Manager/General Contractor</li> </ul>
Defining relational contracting from the Wittgenstein family-resemblance philosophy (Yeung, Chan, & Chan, 2012)	382	<ul style="list-style-type: none"> <li>• Relational Contracting</li> <li>• Project partnering</li> <li>• Strategic partnering</li> <li>• Project alliancing</li> <li>• Strategic alliancing</li> <li>• PPP</li> <li>• Joint Venture</li> </ul>
Reducing Hindrances to Adoption of Relational Behaviors in Public Construction Projects (Ning & Ling, 2013)	369	No contract types identified
How relational contract theory influence management strategies and project outcomes: a systematic literature review (Nwajei, 2021)	368	<ul style="list-style-type: none"> <li>• Project Alliancing</li> <li>• Project Partnership</li> <li>• Integrated Project Delivery (IPD)</li> </ul>

From analysing the most cited papers and the papers with the strongest bibliographic coupling, see Table 3, there are three types of relational contracts generally recognised; Partnering, Alliancing and Integrated Project Delivery (IPD).

This sentiment is clearly stated in Engebø et al. (2020):

“The core collaborative project delivery methods in construction project are Partnering, Alliancing, and IPD.” (Engebø et al., 2020, page 295)

Within partnering and alliancing sup-types of “project” and “strategic” are identified, denoting project based and multi project contracts respectively. While other things are mentioned in the papers as relational contract types they generally fall into two categories; procurement methods that can benefit from relational contract elements and tender methods that support relational contracts. In the first category are procurement methods such as PPP and Joint Venture and while these can benefit from relational contract elements they can also be made completely with traditional procurement methods. In the second category falls tender methods such as competitive dialogue and long-term contracting.

Partnering, Alliancing and IPD are further examined in the literature reviews in the next sub-sections. In order to find representative definitions for partnering, alliancing and integrated project delivery, the same search strategy was used as show in the previous section. First a search term iteration in order to get the results to a manageable size in the search engine WoS. The size in this case is under one thousand results. Then the data is downloaded into VOSviewer in order to make a bibliographic coupling analysis. In the bibliographic coupling analysis, results which have been included but does not relate to the general corpus of results were identified and removed. The strongest coupled documents are then analysed for key attributes and these are put into a table.

### 2.1.2 DEFINING PARTNERING

The first relational contract type is Partnering. While partnering is a very generally used word in many research fields, making the word an exact match using quotation marks and including AEC and construction reduced the results to 706 as seen in Table 3.

*Table 3 Search term iteration for partnering (search date on WoS was May 28<sup>th</sup> 2022)*

Search term	Results
Partnering	267699
“Partnering”	8114
“Partnering” AND AEC OR Construction	706



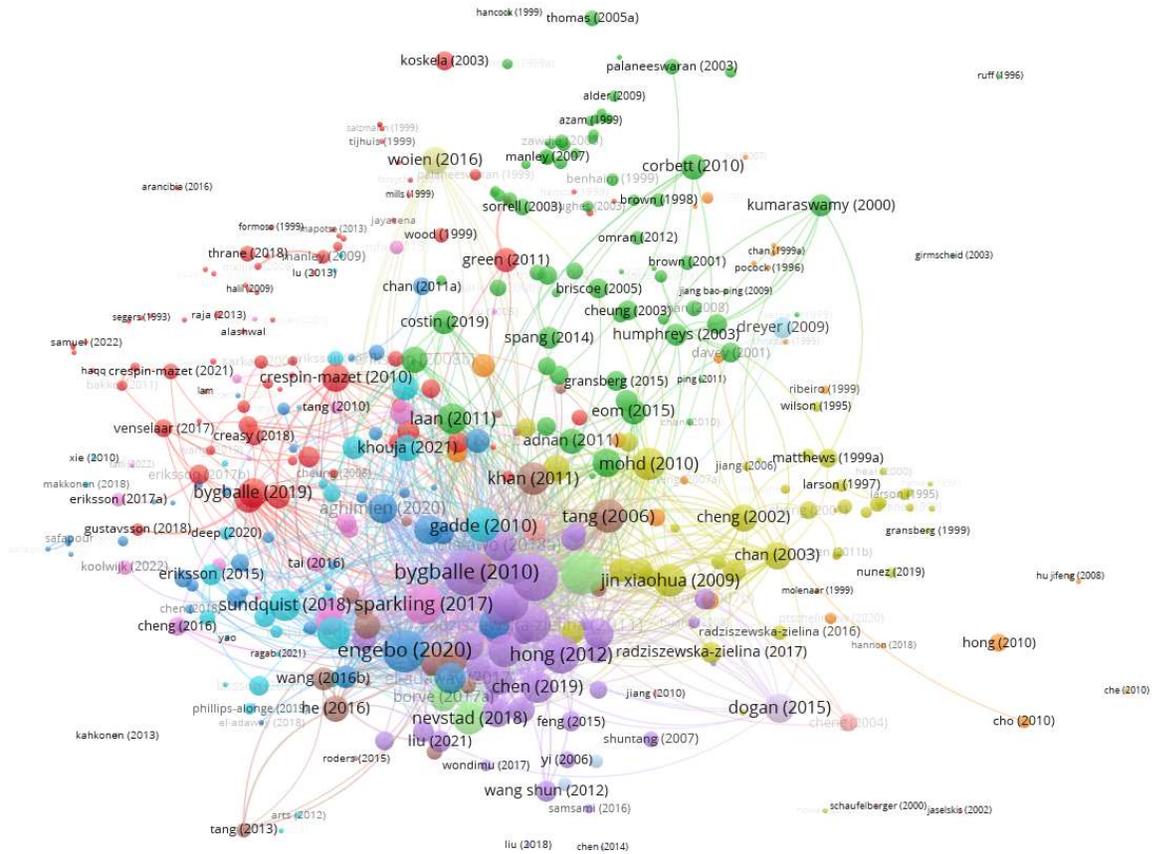


Figure 7 Bibliographic coupling network for partnering

In the bibliographic coupling network analysis using VOSviewer 413 documents had sufficient data to be included in the analysis, see Figure 7. The field is fairly cohesive with only a single big cluster and no clearly defined other clusters. The ten documents with the highest bibliographic strength score were analysed in order to find the key attributes associated with partnering, and thus can help to create a general definition of partnering. These key attributes can be seen in Table 4.

Table 4 Key attributes for partnering

Reference	Strength	Key attributes
Partnering relationships in construction: A literature review (Bygballe, Jahre, & Swärd, 2010)	1497	<ul style="list-style-type: none"> <li>Relationship development (engineered, social and evolutionary aspects or both)</li> <li>Duration (project, strategic or both)</li> <li>Number of actors involved (dyadic, multiple or both)</li> </ul>
Partnering research within the construction industry (1990-2018): a scientometric review (Y. Zhang, Yuan, Zhao, Ning, & Zheng, 2020)	1466	<ul style="list-style-type: none"> <li>Organisational commitment</li> <li>Equity</li> <li>inter-organisational trust</li> <li>Communication</li> <li>Shared goals,</li> <li>Timely response to problems</li> <li>Joint problem resolution</li> <li>Continuous improvement and evaluation</li> </ul>
Conceptual Model of Partnering and Alliancing (Anvuur & Kumaraswamy, 2007)	1269	<ul style="list-style-type: none"> <li>Workshops</li> <li>Champions' meetings</li> <li>Charters</li> <li>Decision-making procedures</li> <li>Incentives</li> <li>Periodic performance evaluation</li> </ul>
Collaborative project delivery methods: A scoping review (Engebø et al., 2020)	1292	No specific attributes found
Research Synthesis Connecting Trends in Architecture, Engineering, and Construction Project Partnering (Sparkling, Mollaoglu, & Kirca, 2017)	1116	<ul style="list-style-type: none"> <li>Partnering workshops</li> <li>Mutual goals</li> <li>Objectives effectively communicated</li> <li>Team-building sessions</li> </ul>
Critical Analysis of Partnering Research Trend in Construction Journals (Hong, Chan, Chan, & Yeung, 2012)	969	<ul style="list-style-type: none"> <li>Commitment</li> <li>Mutual trust and respect</li> <li>Communication</li> <li>Equity</li> <li>Responsiveness to problems</li> <li>Continuous evaluation</li> <li>Common goals,</li> <li>Joint problem resolution</li> </ul>
Fuzzy control of partnering relations of a construction enterprise (Radziszewska-Zielina, 2011)	867	No specific attributes found
Analysis of the partnering relations of polish, slovak and ukrainian construction enterprises (Radziszewska-Zielina, 2010)	859	<ul style="list-style-type: none"> <li>Price is not the most important</li> <li>Number of suppliers limited to best partners</li> <li>Quality control performed by supplier. Buyer trusts a proven partner</li> <li>Precise definition of share in costs, profit and risk related to contract execution. Win-win strategy</li> <li>Buyer and supplier together plan their actions</li> <li>Active, common effort towards constant improvement of services</li> <li>Mutual relations often informal, based on trust</li> <li>Communication: open, frequent, initiated by both parties</li> <li>Information exchange. Open, quick information flow</li> <li>Solving conflicts together</li> <li>Common values and aims</li> <li>Frequent, permanent contact and permanent relations</li> <li>Complex approach to quality issues</li> <li>Visible trust</li> </ul>

Continued on next page

Partnering in the construction industry-Problems and opportunities (Gadde & Dubois, 2010)	815	<ul style="list-style-type: none"> <li>• Longevity</li> <li>• Adaptations between the buyer and the supplier</li> <li>• Interdependence between the parties</li> <li>• Interaction is continuous and intense</li> <li>• Relationship atmosphere</li> <li>• Mutual orientation</li> </ul>
Partnering Mechanism in Construction: An Empirical Study on the Chinese Construction Industry (Tang, Duffield, & Young, 2017)	759	<ul style="list-style-type: none"> <li>• Mutual Objectives</li> <li>• Attitude</li> <li>• Commitment</li> <li>• Equity</li> <li>• Trust</li> <li>• Openness</li> <li>• Team building</li> <li>• Effective communication</li> <li>• Problem resolution</li> <li>• Timely responsiveness</li> <li>• Efficient information circulation</li> </ul>

There is no universally agreed upon definition of partnering but in the paper by Bygballe et al. (2010) a general reference to the definition of partnering is cited from Construction Industry Institute (CII):

“A long-term commitment by two or more organizations for the purpose of achieving specific business objectives by maximising the effectiveness of each participant’s resources. This requires changing traditional relationships to a shared culture without regard to organization boundaries. The relationship is based upon trust, dedication to common goals, and an understanding of each other’s individual expectations and values. Expected benefits include improved efficiency and cost-effectiveness, increased opportunity for innovation, and the continuous improvement of quality products and services.” (Construction Industry Institute (CII), 1991, page iv)

There are two general forms of partnering; project partnering and strategic partnering (Engebø et al., 2020). The former is focused on a single construction project while the latter is a long term collaboration. Partnering implementation has been studied in detail and looking at the implementation of partnering in US, UK and Denmark significant differences can be found (Tvarnø, 2015). As an example in the UK and Denmark partnering contracts tend to be legally binding while partnering in the US is a non-binding charter. The study by Tvarnø (2015) found as others have that a clear and universally agreed upon definitions cannot be found (Anvuur & Kumaraswamy, 2007; Bygballe et al., 2010).

Partnering have been found to have connections to IPD and Alliancing by several authors. In the paper by Y. Zhang et al. (2020) they write:

“Although the relational project delivery arrangements among partnering, alliancing, and IPD are implemented in different contexts, there are similar integration indicators and theoretical premises among them” (Y. Zhang et al., 2020, page 123)

### 2.1.3 DEFINING ALLIANCING

The second relational contract type is alliancing. The search term iteration in WoS was very simple. Since a search using the exact match for alliancing yielded 97 results, see Table 5, no further refinement of search terms was needed.

Table 5 Search term iteration for alliancing (search date on WoS was April 13<sup>th</sup> 2022)

Search term	Results
"Alliancing"	97

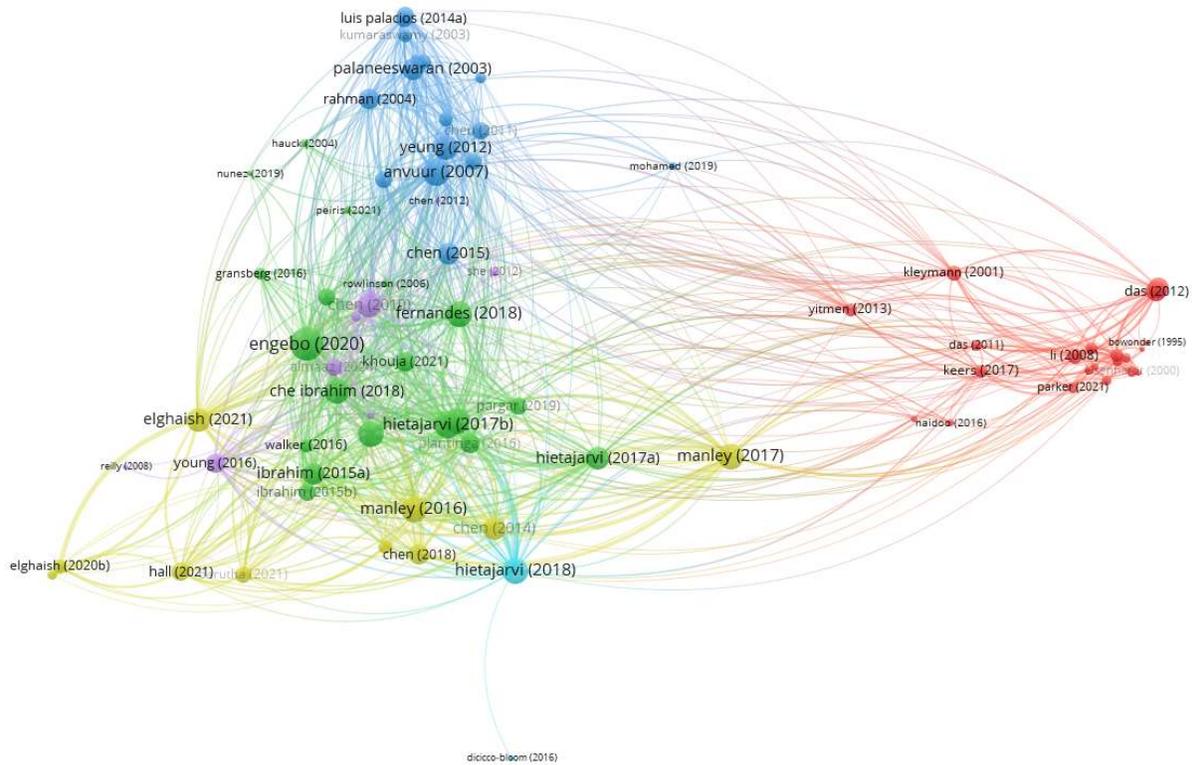


Figure 8 Bibliographic strength mapping of alliancing using VOS viewer

In the bibliographic strength map two clusters are clearly visible; one being coloured red in the map. The red cluster generally contain documents which describe alliancing in other industries but which also to some extent reference the alliancing literature within construction, shown in blue, green and yellow.

The documents with strongest bibliographic strength were analysed to find key attributes describing alliancing, see Table 6.

Table 6 Key attributes for alliancing

	Strength	Key attributes
Collaborative project delivery methods: A scoping review (Engebø et al., 2020)	272	No specific attributes found
Conceptual Model of Partnering and Alliancing (Anvuur & Kumaraswamy, 2007)	188	<ul style="list-style-type: none"> <li>Contractually links the financial success of each of the parties directly to the overall success of the project.</li> </ul>
Managing integration in infrastructure alliance projects: Dynamics of integration mechanisms (A.-M. Hietajärvi, Aaltonen, & Haapasalo, 2017)	175	<ul style="list-style-type: none"> <li>Joint multiparty contract</li> <li>Strong collaboration</li> <li>Integration</li> <li>Early involvement of key parties</li> <li>Transparent financials</li> <li>Shared risks and rewards</li> <li>Joint decision making</li> <li>Collaborative multiparty agreement</li> </ul>
Innovation in alliancing for improved delivery of road infrastructure projects (Che Ibrahim, Costello, Wilkinson, & Walker, 2017)	173	<ul style="list-style-type: none"> <li>Openness</li> <li>Trust</li> <li>Sharing risk</li> <li>Innovation</li> <li>High performance</li> <li>The alignment of commercial interest towards project outcomes</li> <li>Construction phase start while the real cost of the project is still under development</li> <li>Partners are chosen extremely early</li> <li>Inter-firm organizational arrangements</li> <li>All to the project, regardless of their parent organisations</li> <li>Authentic leadership</li> </ul>
Key features of a project alliance and their impact on the success of an apartment renovation: a case study (Fernandes, Costa, & Lahdenperä, 2018)	170	<ul style="list-style-type: none"> <li>Joint contract between key parties to a project</li> <li>Joint responsibility for the design and construction</li> <li>Joint organization</li> <li>Sharing both the positive and negative risks</li> <li>Openness in cost monitoring</li> <li>Openness in information accessibility</li> <li>Risk and gain-share principle</li> </ul>
The impact of client characteristics on the time and cost performance of collaborative infrastructure projects (Manley & Chen, 2016)	167	No specific attributes found
Collaborative Learning to Improve the Governance and Performance of Infrastructure Projects in the Construction Sector (Manley & Chen, 2017)	165	<ul style="list-style-type: none"> <li>Collective cost estimation</li> <li>Risk and reward sharing regime</li> <li>Service provider penalties</li> <li>Informal mechanisms</li> <li>Relationship managers</li> <li>Leadership skills</li> <li>Team workshops</li> <li>Communication systems</li> <li>Design integration</li> </ul>
Towards a Coherent Theory of Project Alliancing: Discovering the System's Complex Mechanisms Yielding Value for Money (Lahdenperä, 2017)	164	<ul style="list-style-type: none"> <li>Joint contract between the key actors</li> <li>Joint responsibility for the design and construction</li> <li>Joint organisation</li> <li>Share positive and negative risks related to the project jointly</li> <li>Principles of information accessibility</li> <li>Unanimous decision-making</li> </ul>

Continued on next page

The formation of a collaborative project identity in an infrastructure alliance project (A. M. Hietajärvi & Aaltonen, 2018)	161	<ul style="list-style-type: none"> <li>• Share any wins and losses</li> <li>• Social benefit beyond financial and short-term impacts</li> <li>• Joint responsibility for consensus decision-making</li> <li>• Joint responsibility for risk taking</li> <li>• Strong commitment from all participating actors</li> <li>• Shared organizational identity</li> <li>• Each party is responsible for working in the best interests of the project</li> <li>• Committing to the project as an entity</li> <li>• Incentivization contract</li> <li>• Behavioural contract</li> </ul>
Making sense of team integration practice through the “lived experience” of alliance project teams (Che Ibrahim, Costello, & Wilkinson, 2018)	157	<ul style="list-style-type: none"> <li>• an agreement between two or more partners who undertake to work collaboratively</li> <li>• Behavioural set of contract conditions</li> <li>• Collective shared risk and reward</li> <li>• Collaborative culture</li> <li>• Equitable relationships</li> <li>• An atmosphere that is open and non-competitive</li> <li>• Collaborative environment</li> <li>• The team is committed to channelling all talent and energy for the best possible project outcome</li> </ul>

The key references to define alliancing and its early development concerned the petrochemical industry:

“Particular attention has been given to ACA (1999) who reported how the first alliance project in Australia, the Wandoo B Offshore Oil Platform project...” (Che Ibrahim et al., 2017, page 703)

This is echoed in:

“PA [project alliancing] has its roots in industries other than construction. In 1992 British Petroleum launched a collaboration process for an oil project in the North Sea...” (Lahdenperä, 2012, page 60)

In the alliance literature the three main relational contract types are also identified to be partnering, alliancing and IPD. An example of this is from Hietajärvi et al. (2017):

“The literature identifies at least three forms of collaborative arrangement: project alliancing, integrated project delivery and partnering.” (Hietajärvi et al., 2017, page 8)

It is also noted in the literature the close relationship between alliancing and IPD. That IPD is a much newer relational contract type can be is also commented upon.

“...there is a new model emerging in the USA which is very similar to project alliances in these respects; this is called integrated project delivery.” (Manley & Chen, 2016, page 513)



Table 8 Key attributes for IPD

Reference	Strength	Key attributes
Collaborative project delivery methods: A scoping review (Engebø et al., 2020)	578	No specific attributes found
Enhancing Subcontractors' Participation in BIM-Based Design Coordination under a DBB Contract (S. Jang, Jeong, Lee, & Kang, 2019)	555	<ul style="list-style-type: none"> <li>• Participating parties collaborate as a single team to optimize the design</li> <li>• Profit sharing is offered once the project target cost is reached</li> </ul>
Barriers to the use of integrated project delivery (IPD): a quantified model for Malaysia (Durdyev, Hosseini, Martek, Ismail, & Arashpour, 2020)	543	<ul style="list-style-type: none"> <li>• All disciplines involved in a construction project work and treat each other as members of a single firm</li> <li>• Multiparty agreement</li> <li>• Very early involvement of key participants</li> <li>• Collaboration</li> <li>• Pursuit of mutual goals</li> <li>• Sharing the risks and rewards</li> <li>• Collective environment</li> <li>• Maximising communication among project stakeholders</li> </ul>
Integrated project delivery with BIM: An automated EVM-based approach (Elghaish, Abrishami, Hosseini, Abu-Samra, & Gaterell, 2019)	528	<ul style="list-style-type: none"> <li>• Early engagement of key stakeholders,</li> <li>• Collaborative engagement of key stakeholders</li> <li>• Collective engagement of key stakeholders</li> <li>• Risk/reward compensation</li> <li>• Joint project control</li> <li>• Target cost</li> <li>• Profit-at-risk</li> <li>• Dynamically integrated cost management system</li> <li>• All members must be continuously involved</li> </ul>
Revolutionising cost structure for integrated project delivery: a BIM-based solution (Elghaish, Abrishami, Hosseini, & Abu-Samra, 2021)	519	<ul style="list-style-type: none"> <li>• Early involvement of contractors</li> <li>• Shared space where team members or representatives work</li> <li>• Open pricing</li> <li>• Fiscal transparency</li> <li>• Profit and shared risks</li> <li>• Cost estimation</li> <li>• Continuous estimation feedback</li> </ul>
Trends of integrated project delivery implementations viewed from an emerging innovation framework (Rashed & Mutis, 2021)	496	<ul style="list-style-type: none"> <li>• Integrates people</li> <li>• Integrates systems</li> <li>• Integrates business structure</li> <li>• Harnesses the talents and insights of all participants</li> <li>• All project stakeholders evaluate the financial performance of design decisions</li> <li>• All parties attuned to the overall project benefits</li> <li>• Cost savings are shared among participants</li> <li>• Improved team environment</li> <li>• Defines models for formal contracts</li> <li>• Defines models for informal relationships between organizations</li> <li>• Aligning the incentives and goals of the project team</li> <li>• Shared risk and reward</li> <li>• Project participants'</li> <li>• Early involvement</li> <li>• A multi-party agreement</li> </ul>

Continued on next page



How Do Relational Contracting Norms Affect IPD Teamwork Effectiveness? A Social Capital Perspective (L. Y. Zhang, Huang, Tian, & Guo, 2020)	483	<ul style="list-style-type: none"> <li>• An open and collaborative entity consisting of key contracting parties' representatives</li> <li>• Assembled early in the project process</li> <li>• Aligned goals</li> <li>• Multiparty relational contract</li> <li>• Members are expected to contribute their knowledge and expertise</li> <li>• Share information</li> <li>• Trust each other</li> <li>• Collectively manage and share risk</li> <li>• Truly and deeply cooperate</li> </ul>
Team Integration and Owner Satisfaction: Comparing Integrated Project Delivery with Construction Management at Risk in Health Care Projects (Choi, Yun, Leite, & Mulva, 2019)	472	<ul style="list-style-type: none"> <li>• Team integration throughout the design and construction phases</li> <li>• Multiparty agreement</li> <li>• Risk and reward sharing</li> <li>• Collaborate to develop and validate project goals</li> <li>• Share risk and incentives</li> <li>• Multiparty contract</li> </ul>
A synthesis of best-value procurement practices for sustainable design-build projects in the public sector (Molenaar, Sobin, & Antillon, 2010)	471	No specific attributes found
Comparative analysis between integrated project delivery and lean project delivery (Mesa, Molenaar, & Alarcón, 2019)	458	<ul style="list-style-type: none"> <li>• Contractual agreement between a minimum of the owner, design professional, and builder</li> <li>• Risk and reward are shared</li> <li>• Stakeholder success is dependent on project success</li> </ul>
Governing Collaborative Project Delivery as a Common-Pool Resource Scenario (Hall & Bonanomi, 2021)	458	<ul style="list-style-type: none"> <li>• Share the project resource pool,</li> <li>• Share the project decision-making rights</li> <li>• Share in the project outcome.</li> <li>• Share the financial risks and rewards</li> </ul>

A key reference to define IPD is American Institute of Architects (AIA) (Mesa et al., 2019):

“Integrated Project Delivery (IPD) is a project delivery approach that integrates people, systems, business structures and practices into a process that collaboratively harnesses the talents and insights of all participants to optimize project results, increase value to the owner, reduce waste and maximize efficiency through all phases of design, fabrication and construction.” (AIA, 2007)

IPD has a close association with alliancing. In some of the literature this connection is described as the two relational contract forms being identical.

“IPD, though a relatively new and still evolving concept, was first introduced to address these problems, in Australia, in the early 1990s. It was originally known as “Alliancing”, but it was later termed as IPD in the USA.” (Durdyev et al., 2020, page 188)

This interpretation is however not shared by all researchers in the field and IPD is more seen as an advanced form of the more traditional form of relational contracts.

“Traditional forms of IPD, like alliancing and partnering agreement...” (Elghaish et al., 2021, page 1215)

As the previous three subsections show many key attributes are shared between the three relational contract forms. Furthermore in all three literature reviews references to the close connections can be found. The key attributes and the connections between relational contract types is described in section 6.4 with a comparison of strategic partnerships and a taxonomy of relational contracts.

The next three sections contain the systematic literature reviews that were made as part of the three scientific papers in the PhD research presented in this thesis.

## 2.2 PROCUREMENT INNOVATION AND STRATEGIC PARTNERSHIPS

After a general search and understanding of relational contracts as a relevant area of research with regard to procurement strategies that can support sustainable renovation, strategic partnerships were chosen as the focus. This procurement practice is relatively new in the Danish construction industry and so was of interest to understand in the local context.

The literature review does not seek to describe innovation in general or procurement innovation as a concept. The goal was to understand strategic partnerships as a procurement innovation, how it is defined and which relationships it has to other procurement types such as alliancing and partnering.

On a broader scale it was interesting to identify if strategic partnerships was a procurement innovation and how it compared to other relational contract schemes.

A number of questions were formulated, which the review should be able to answer:

- How are strategic partnerships, strategic partnering, strategic alliancing and strategic collaboration described in the literature?
- How are these governance types defined and how do they differ?
- Who are the main authors active in the area?

The search was conducted on the 20<sup>th</sup> of May 2019 and had a broad dataset. Three databases were used; Web of Science, Scopus and EBSCOhost. The latter containing non-scientific publications. The search term iteration went through three rounds before finally ending on an acceptable 2,202 entries. The search string is:

*strategic\* AND (partnering OR partnership\* OR alliance\* OR collaboration\*)  
AND (construction OR renovation) (Language: English) (Year 2010-2019)  
(NOT Marketing, Trade, Car, China)*

The reason for including the NOT statements was that these terms were commonly found in entries, which were irrelevant to the search. From the 2,202 entries, 158 were found to have relevant titles and after reading the abstracts, 99 entries were kept. Then the entries were cross-

checked between the database and 18 duplicates were found. In the end, 81 articles and documents were used as part of the analysis.

When studying the literature on relational contracts in construction it was possible to construct a taxonomy of ideas, describing how the procurement systems recognized today have common ancestors. There are two key reference points for relational contracts referenced in the literature; “Constructing the team: Joint review of procurement and contractual arrangements in the United Kingdom construction industry”(Latham report) (Latham, 1994) and “Cost Reduction: Initiative for the New Era” (CRINE) (Spaven, 1993). The latter is also referred to as a “British Petroleum initiative” in the literature (Plantinga & Dorée, 2016). Both were undertaken in the UK at the same time and in the Latham report CRINE is directly referenced as a concurrent initiative:

*“It [CRINE] makes similar recommendations to those in this Report, such as using standard equipment and simplifying and clarifying contract language and eliminating adversarial clauses.” (Latham, 1994)*

Before this point there are references to dispute resolution efforts in the US and partnering, but it is from CRINE and the Latham report that the modern relational contracts in construction are derived. Three descendants can be identified as Alliancing, Integrated Project Delivery (IPD) and Partnering, echoing the findings from the scoping literature review in sub section 2.1.1. Alliancing is derived from the CRINE work and is most prevalent in Australia, New Zealand and Finland (Ibrahim et al., 2017). Partnering on the other hand comes from the Latham report and is found in the UK and Sweden (Eriksson, 2010). IPD was developed almost ten years later than the other two in the US and arguably has influences from both Alliancing and Partnering (Lahdenperä, 2012). More long term variants of both partnering and alliancing exist, strategic alliancing and strategic partnering (Sundquist et al., 2018, Davis & Love, 2011). As shown in section 6.4 strategic partnerships as they are found in the Danish construction industry can trace their lineage to the ideas of strategic partnering and the Latham report.

When reviewing the existing literature research gaps were identified in two general areas. Either the literature measured the outcomes of implementing a procurement strategy or the focus was on how a procurement strategy is implemented. This research is however not very detailed in terms of the development of the procurement strategy nor does it detail how the particulars of a strategy is created. This is a research gap that a paper on the procurement innovation and development of strategic partnership could help to fill. Similar previous work has been done by Tvarnø (2015) in her comparison of partnering contracts in Denmark, UK and the US. The identified research gaps prompted the first paper in the PhD study on procurement innovation, see section 6.1 and appendix A.

## 2.3 PROCUREMENT STRATEGY AND MATURITY MODELS

A recurring question that came up in interactions with practitioners and when having general discussions about procurement innovation in construction and strategic partnerships in particular was the question of “When does it make sense to use?” Either strategic partnerships is the superior procurement strategy in all situations or there has to be situations where another procurement strategy would work better. The question is then whether there is a model that can be used for such an analysis, and maturity models were chosen as a framework that is both simple to communicate and has sufficient nuance.

The second literature review was conducted to establish state of the art within the use of maturity models in construction research. While this type of model has its origin in the software industry, it has been used in the construction industry and so the questions sought answered by the literature review was:

- Where and to what degree are maturity models used in construction?
- What are the models used for?
- Which types are common and how were they structured?

The search was conducted on the 19<sup>th</sup> of January 2017 and the database Scopus were used to conduct the search. The search term string was:

*“maturity model” AND construction*

From this single iteration of the search terms, 163 entries were found and a subsequent result selection found that 41 were relevant from reading the title of the documents. In the end, 26 of the documents were deemed relevant after reading the abstracts, and used to answer the questions posed as part of the literature review. In the literature four construction specific maturity models were found and can be seen in Table 9.

*Table 9 Construction specific maturity models*

Model name	Area of analysis	Paper
Supply Chain Relationships in Construction (SCR)	Procurement	(Meng, Sun, & Jones, 2011)
Management Maturity Model	Project management	(Langston & Ghanbaripour, 2016)
Project Management Nine Knowledge Areas	Knowledge of project managers	(Rasid, Wan Ismail, Mohammad, & Long, 2014)
Public Commissioning Maturity Model	Commissioning	(Hermans, Volker, & Eisma, 2014)

The construction specific maturity models were used to assess maturity of construction organizations regarding very diverse subjects. In the literature search one maturity model was found to be exactly related to the field of interest of the PhD research; procurement strategy. The work of Meng et al. (2011) had resulted in the SCR maturity model and focused on maturity in relation to procurement strategy.

In the SCR maturity model Meng et al. (2011) uses four steps in a graphical step model very similar to the CMM, see Figure 10. The levels are very relevant to the PhD research since they were; Price competition, Quality competition, Project Partnering and Strategic partnering/alliancing. It has a Key Attribute (KA) matrix with 24 categories describing each of the four levels and listed a detailed description of the relationship between buyer and supplier at each maturity level. For an in depth description of maturity models see section 5.2.

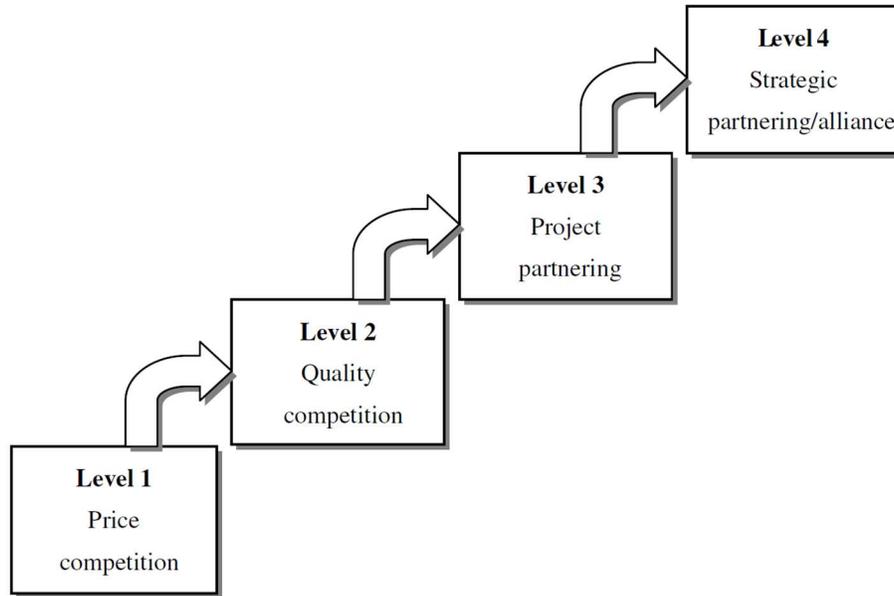


Figure 10 SCR - Construction supply chain maturity levels from Meng et al., (2011)

The KA matrix in the SCR model has eight main criteria; Procurement, Objectives, Trust, Collaboration, Communication, Problem solving, Risk allocation and Continuous improvement. Each having three sub-criteria. As an example the “Procurement” criteria has the three sub-criteria; Selection criteria, procurement route and form of contract.

The model however did have fundamental issues when it came to use it as an analysis tool and throughout the construction value chain. This is mentioned as a route of further research and improvement in the Meng et al. (2011) paper. The research gap was therefore determined to be the further development of the SCR maturity model. The following potential improvements were identified in both the graphical representation of the maturity steps and the KA matrix.

Improvements to the graphical representation of maturity steps:

- The SCR model assumes a life cycle perspective, but the buyer supplier relationship should be based on deliberate analysis according to Transaction Cost Economics theory. A potential performance perspective would be more appropriate.
- There is a value associated with increasing maturity level but there is also complexity associated. The graphical representation could reflect this by placing the maturity steps in a Cartesian coordinate system with an x-axis labelled complexity and y-axis labelled value.

Improvements to the KA matrix:

- The KA matrix is too large, making analysis cumbersome and in some cases a development distinction between two levels cannot be justified.
- There are no complexity parameters described in the matrix making it seem like the most mature procurement scheme is the most favourable in all cases.
- The KA matrix has direct references to procurement documents only relevant in a UK context.

The second paper in this PhD thesis is based on this analysis and identified research gap, see section 6.2 and appendix B.

## 2.4 BUSINESS MODELS IN CONSTRUCTION

The main point of the literature search on business models and the construction industry was to determine the state of the art within the field. From the beginning three scientific databases were selected; Scopus, Web of Science and EBSCOhost. The two first were mainly for scientific references while the third, EBSCOhost, contain publications of a non-scientific character and since business models have been used extensively by practitioners in some industries such sources seemed important to include.

As part of the literature review, a number of questions were formulated to be answered by the search:

- How many papers look at business models in construction? Of these, how many models are used and which?
- Does the paper offer a definition of the term business model?
- Is the paper focused on a technological innovation or a business model innovation?

The review was conducted the 15<sup>th</sup> of November 2019 and the subsequent analysis were conducted after this date. In all two iterations of searching were needed to get an appropriate number of entries, which in this case were 2,315 papers and documents in the total from the 3 databases. The final search string is:

*“Business model” AND construction (year 2011-2020)*

After finding the entries, the result selection started to answer the questions of the review. To do this all 2,315 entry title were read and of these 196 were determined to be relevant. Of these, 14 duplicates were identified across the three databases results and these results were then reduced to a single result giving a total of 182 unique entries. From this proto list, 102 were deemed relevant after reading the abstract and became the data source to answer the questions.

From the analysis of the papers 14 different business model assessments, see Table 10, of the construction industry were found. The trends in the business model assessments is the predominant use of bespoke business model frameworks and only looking at a single company or company type. Several researchers also noted that it was difficult to discuss business models with practitioners and that complicated business model frameworks made it difficult to make conclusions based on the data collected from said practitioners. The research gap identified here is that there have not been published business model analysis using parsimonious models from the construction industry with a cross value chain perspective. Furthermore no assessment of friction between and inside companies associated with change in business models as a result of change in the construction value chain, e.g. strategic partnerships, have been made. This research gap prompted the writing of the third paper on friction and business models, see section 6.3 and appendix C.

Table 10 Business model types and analysis on construction companies from literature from (Berg, Thuesen, Ernsten, & Jensen, 2021)

Business model framework	Scope	Analysis	Reference
Green Business models	Multinational enterprises (MNEs)	Barriers	(Hart et al., 2019)
Business Model Canvas (modified)	Business network	Business model change	(Mokhlesian & Holmén, 2012)
Bespoke Business model framework NICE	Zero Carbon Buildings Developer, Contractor, FM Service provider	Business model innovation Value drivers and value appropriation	(Zhao et al., 2016) (Rajakallio et al., 2017)
Bespoke Business model framework	International construction companies	Firm performance	(Jang et al., 2019)
Bespoke Business model framework	Consultancy	Business model reconditions	(Florence Yean Yng Ling & Li, 2016)
Bespoke Business model framework	Manufacturer of prefabricated buildings	Development of business model framework	(Brege et al., 2014) (Lessing & Brege, 2018)
Business Model Canvas (modified)	Manufacturer of building materials	Description of business model	(Nußholz, Nygaard Rasmussen, & Milios, 2019)
Teece Business model framework	Building client and AEC companies	Sustainable renovation	(Jonsson et al., 2017)
Business model Canvas	Building client and AEC companies	Energy efficiency Conservation Retrofit	(Dunphy et al., 2016)
Business model Canvas	Sub-contractor	Ecosystem business model	(Laine et al, 2017)
Bespoke Business model framework	Architect	Business models for architectural service delivery	(Bos-De Vos et al., 2016)
Bespoke Business model framework	Building client and AEC companies	Sustainable Innovation	(Romero et al., 2016)
Bespoke Business model framework	Zero Carbon Buildings	Typology of business model innovations	(Zhao et al., 2018)

### 3 RESEARCH QUESTION

From the purpose statement in section 1.4 and the literature reviews in the previous chapter there are clear research gaps and an important research goal, which this PhD thesis seeks to answer. In terms of research questions this thesis has a main research question and three sub questions. Each of the sub questions answers a specific part of the main research question and this is done through a research paper for each of the sub questions.

Main research question:

“How do actors in the construction value chain react to the relational contracting practice of strategic partnerships in terms of procurement strategy, organizational maturity and their business models?”

The three research gaps identified, detailed in chapter 2, are addressed in three papers. One paper on the transaction between building client and AEC companies. Another paper on the building client procurement practices and maturity of procurement processes. The third paper addresses AEC companies and their business models. The research gaps combined with discussions with academics and practitioners helped define the exact topics of research.

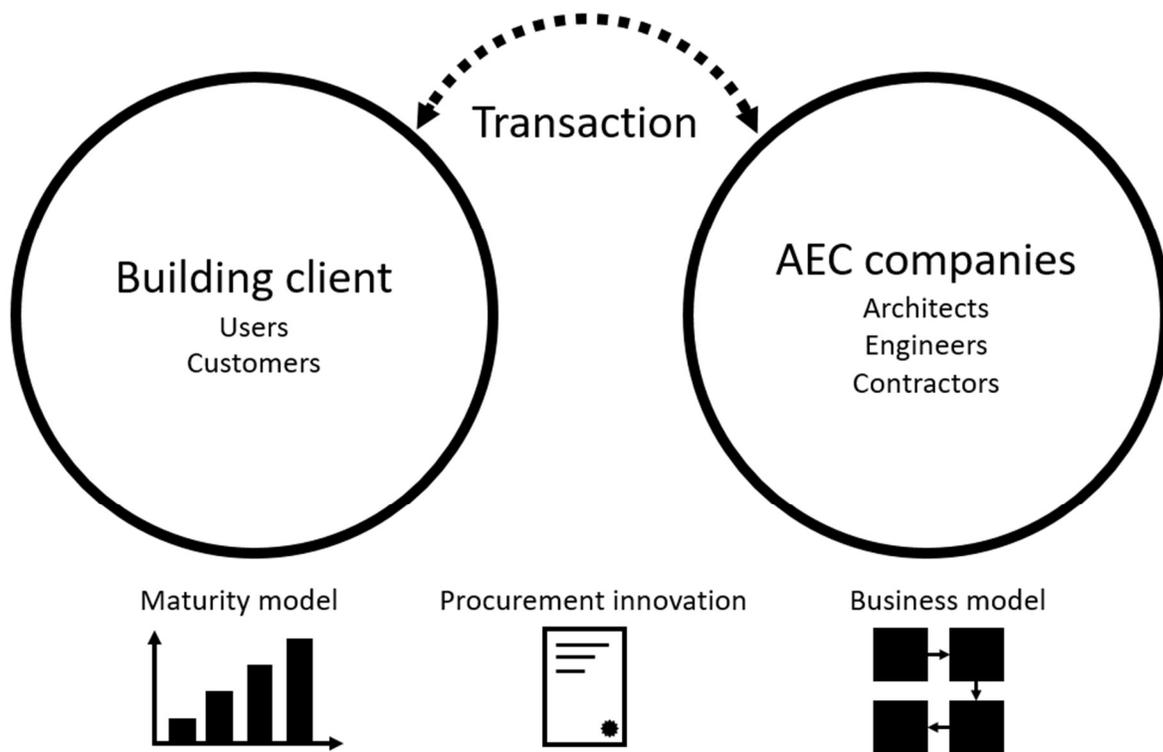
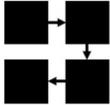


Figure 11 The three areas of research addressed in the PhD thesis



The three areas of the research question is exemplified in Figure 11. The three research gaps and the sub-research questions can be seen in Table 11.

Table 11 Overview of papers, research questions and data gathering method

	Transaction	Building client	AEC companies
			
Reference	(Berg et al., 2022a)	(Berg et al, 2022b)	(Berg et al., 2021)
Title	Procurement innovation as a vehicle for sustainable change – a case study of the Danish model of strategic partnerships	Understanding transactions: A maturity model for construction supply chain relationships	Reconfiguring the construction value chain: Analysing key sources of friction in the business model archetypes of AEC companies in strategic partnerships
Research question	<i>“How is a procurement innovation supporting sustainable building renovation, in the form of strategic partnerships, defined and replicated?”</i>	<i>“How can a maturity model of procurement relationships in construction be created, in such a way that it takes into account both the positive and negative attributes of using mature procurement relationships such as strategic partnerships?”</i>	<i>“What are the points of friction in and between business model archetypes when they are subject to transformation in the value chain in the form of strategic partnerships?”</i>

The first gap identified was the description of what a strategic partnership actually is, see the literature review in section 2.2. While the term “Strategic partnership” were used to describe a number of relationships between companies and organisations, these were often not well defined and did not fit the reality of the construction industry. Similarly definitions for similar contracting schemes like strategic partnering did not fit the cases found in Denmark either and so there was a gap in the literature. How strategic partnerships are compared to other relational contract types is described in section 6.4 including a taxonomy of relational contracts. In the literature the development of new contracting types in construction is often not described in detail. Once a contracting type is defined and has been used several times in practice and is established practice, it is then evaluated and examined by academics. This leaves out critical development steps, and if the construction industry in another country wants to replicate a procurement practice, they do not have access to all of the steps necessary to implement the practice in their local context.

The second gap was identified when discussing strategic partnership and the question of; when is it appropriate it use this procurement scheme? It was a stated goal from many practitioners

that they wanted to reduce transaction costs like tender costs, but strategic partnerships comes with a large number of other transaction costs, mostly related to governance. To evaluate different types of relationships, especially in government procurement, maturity models have been used successfully for decades. This prompted the literature search in section 2.3. A systematic search for maturity models in construction did yield a previous model, see Table 9, but this model had a number of limitations. The gap was identified as improving the model both in terms of the graphical representation and the KA matrix.

The third gap was first identified while talking to practitioners from companies and discussing how their work would change as a result of working in a strategic partnership. It was interesting to see if there were some inherent problems between the companies working together in strategic partnerships. Using business models frameworks was determined to be a good perspective to find these points of friction. A literature search, see section 2.4, revealed that business model frameworks had been used before in construction industry research, however it also revealed a number of shortcomings. Firstly the prevalent use of bespoke business model frameworks and using this framework to only look at a small subsection of the construction industry. The second was the complaints of several researchers that it was difficult to get reliable data, since the practitioners did not sufficiently understand complex business model frameworks. Lastly there was little effort put into establishing a baseline from which to examine changes. So the gap was to use established business model frameworks, interact with practitioners with business model frameworks that were sufficiently simple that they understood them and establish a baseline or archetypes from which to make an analysis of friction associated with participating in strategic partnerships.

In the following Chapter the philosophical foundation of the research is presented together with the research approach.

## 4 METHODOLOGY

To conduct the research and in the end come up with answers to the research questions it is important to outline the approach, assumptions and method of the research. Following this is a section on research philosophy and approach that details the philosophical foundation for the research. The research methods are described in section 4.2 and the empirical data collection and analysis in section 4.3. In the last two sections of this chapter triangulation of data and reliability and validity of the results is described.

### 4.1 RESEARCH PHILOSOPHY AND RESEARCH APPROACH

Scientific research should always be made with a solid philosophical foundation. In Saunders et al. (2008) four main research philosophies, see Table 12, or schools of thought in management research are described; Positivism, Interpretivism, Realism and Pragmatism. Each of the four research philosophies are described in terms of their ontology, epistemology, axiology and most used data collection techniques. Ontology is the underlying assumption about the nature of reality, which the researcher interacts with and can create knowledge from. Epistemology concerns the type of knowledge that is acceptable in a specific scientific field. The axiology is the view the researcher has on the values in research. To support the ontological, epistemological and axiological view of the researcher a certain type of data collection becomes the most appropriate.

*Table 12 Accepted research philosophies in management research (Saunders et al., 2008)*

Positivist	A positivist view the world is objective and independent of social actors. The researcher's task is to reduce phenomena to the simplest elements possible and build generalizable laws from this set of simple elements. A researcher can be seen as an objective observer and independent from the data. The data collection is highly structured using large data sets with predominantly quantitative measures.
Interpretivist	In the interpretivist view the world is a social construct, it is subjective and it is subject to change. The researcher's task is to describe social phenomena and subjective meaning, with a focus on detailed description of situations where actions are motivated by subjective meaning. A researcher is part of what is being researched and as such is subjective since the researcher cannot be separated from the research. The research relies on data from small sample sets that are in-depth qualitative investigations.
Realist	In realism the world is external and objective but it is interpreted through social conditioning. The researcher's task is to collect data that can be observed but at the same time this data will be incomplete. It is also possible that the data can lead to misinterpretation. A researcher is biased by prior experiences, worldview and upbringing, meaning that the researcher will influence the results of the research. The research data can be both qualitative and quantitative and it must fit the subject of the research.
Pragmatist	As a pragmatist the researcher sees the world as external but the researcher can change view depending on the research question which the researcher seeks to answer. The researcher's task is to collect either or both objective data and subjective meaning, depending on what can best answer the research question. A researcher has values which influence the interpretation of the data and both objective and subjective views can be applied. A mixed method approach can be used with both quantitative and qualitative data providing the basis for meaningful insights.

As a researcher, it is important to produce knowledge in a way that is generally accepted. All of the four approaches described in Table 12 have been accepted by management researchers. The research conducted as part of the PhD project has as a foundational assumption that examining phenomena in the world can reveal insights into the nature of reality. This makes it congruent with ontology of positivism, realism and pragmatism.

As the main focus of the PhD research has been on a company level, how to view the companies plays a big role in the choice of research philosophy. In companies, structures and measures are set up in such a way that a desired outcome will happen. It is assumed that the functioning of the organisation is more or less independent of the individuals, who comprise the organisational structure. In this view, social structures persist independent of human interpretation. This enables the creation of models and explanatory analysis like business models, which do not look at a very granular level of the organisations. The structures examined and the models created are independent of the individual in the organisation. Since the data collected as part of this PhD study comes from practitioners and documents, this cannot be argued as giving full access to all objective facts. The epistemological view has to take this into account. This is why the research philosophy of realism offers the most suitable epistemological view for the research conducted in this PhD. It assumes that there exist objective facts, but that these are often not fully accessible and can be subject to misinterpretation. In this way the research takes the view of realism.

In realism there is a real objective world that it is possible to interact with. The problem is that the objective thing may be very complicated or complex, like a large organisation, where it is impossible to get complete information about the state of the world. Realism can be further developed into critical realism by an additional ontological assertion. The critical realist also assumes that the information about the world is interpreted by the observer. All the previous knowledge and bias that the observer has will in some way affect the perceived reality. Saunders et al. (2008) gives an example with an umpire who is giving out penalties and scoring points in a cricket match. A critical realist umpire would never say that he knows that his judgement is correct. All he can say is:

*“...the umpire who is the critical realist would say about his umpiring decisions: ‘I give them as I see them!’” (Saunders et al., 2008, page 115)*

In the PhD research the effects of bias is acknowledged, both from the method of data collection, the subject of research and the researcher. As it is described in the following sections on research methods the research design has sought to minimize the bias. This attention to bias is in line with the assumptions made by the critical realist research philosophy. In the realist view both quantitative and qualitative data sources should be used when appropriate. This has been the way the data has been collected as part of the PhD research, and all relevant data sources have been included.

Describing the research approach of a scientific study there are three over-all categories; Deduction, Induction and Abduction. The deductive and inductive approaches are described in Saunders et al. (2008). In the deductive research approach, which can be thought of as the dominant research approach in the natural sciences, theory is developed first. A testable hypothesis is proposed which is then tested with experiment or observation. The test will then either confirm the predictions from the theory or show that the theory has to be either modified or abandoned.

The inductive research approach does on the other hand start with data collection and trying to understand the environment and influencing factors present in a given context. This research approach was developed primarily for social science research, where the methodology and theory development in the deductive approach was seen as inappropriate. The focus in the inductive approach is to understand research context, the meaning humans attach to events and not necessarily creating generalizable results.

The third approach is abduction and is described by Tavory & Timmermans (2014) as:

*“One part empirical observations of a social world, the other part a set of theoretical propositions”* (Tavory & Timmermans, 2014)

In an abductive approach the starting point is the observations of the world. From these explanations of why the observed phenomenon is the way it is leads to the development of theory. This is distinct from the deductive and inductive approaches since abduction does not seek to find causal connections. The aim is to develop plausible descriptions of a world that in many cases cannot be observed directly. In an abductive approach there is also focus on the researcher's ability to identify surprising facts about the world.

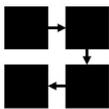
Because of the focus of the PhD research presented in this thesis is on creating models and tools describing companies and organizations, an abductive approach has been taken. When evaluating which models are relevant and which descriptions are meaningful the starting point has been interactions with the construction industry. It was the surprisingly wide range of opinions on what constitutes a strategic partnership that prompted the need for clear definitions of strategic partnerships. The inability of practitioners to describe what an organization should be able to do and focus on in a strategic partnership led to the research in understanding organizational maturity. In the same way the wish to understand how companies interact under novel conditions and the business models used was found as important to understand. From these observations theories were examined that could shed light on the phenomenon and modified if they seemed to contradict data.

When it comes to the data collection technique both qualitative and quantitative methods yield important data. The analysis and cross checking of facts across several data sources is important to ensure that the models created have a chance of having explanatory power. In the following sections, the research methods used to collect data is discussed from a research design perspective. Literature review, scientific interviews, workshops, surveys, and case studies have all been part of the information gathering process in the PhD research presented in this thesis.

## 4.2 RESEARCH METHOD

When looking at the philosophical underpinning of the research, it is not a surprise that both qualitative and quantitative methods have been used throughout the PhD. The subject matter of organisations and management in the construction industry also lends it selves to both quantitative and qualitative data collection. In Table 13 the research methods used as part of the three papers that are part of the PhD research can be seen.

Table 13 Research methods used in the three papers that are part of the PhD research

	Transaction	Building client	AEC companies
			
Reference	(Berg et al., 2022a)	(Berg et al, 2022b)	(Berg et al., 2021)
Research method	<ul style="list-style-type: none"> <li>• Systematic literature review</li> <li>• Workshops</li> <li>• Interviews</li> <li>• Exhaustive case study</li> <li>• Exploratory case study</li> </ul>	<ul style="list-style-type: none"> <li>• Systematic literature review</li> <li>• Workshops</li> <li>• Survey</li> </ul>	<ul style="list-style-type: none"> <li>• Systematic literature review</li> <li>• Workshops</li> <li>• Interviews</li> </ul>

The research method of a scientific study reflects not only the field in which the study is conducted, but also the type of data available to the researcher and the object of the research. When studying the construction industry it is not possible to conduct trial experiments under laboratory conditions at scale, and even if it was, the results of such studies would at best be subject to criticism. This is why natural experiments and field studies are the most appropriate tools to examine the social, technical and cultural interactions, which constitute building and renovation projects. The focus of the research presented in this PhD has been on the companies and organisations involved in the construction industry, and how they interact in the context of a sustainable renovation project. This makes a number of possible data collection opportunities available as well as creating some constraints.

Since the companies and organizations engaged in the renovation of buildings consist of individuals, it is possible to probe them and with a variety of techniques understand the underlying structure of ideas and patterns, which govern their individual behaviour. In renovation projects and procurement, which involves public building clients, it is also possible to gain access to documentation and public documents. To be able to take these data points and extrapolate them to say something meaningful about an entire industry, it is important to not only study the individual but also the interactions between people. Since this research deals with cross value chain interactions these interactions have to be part of the dataset.

Describing the construction industry in purely quantitative data is not enough for the PhD research presented in this thesis. Quantitative data is not sufficient to understand the organisations and companies, which make up this industry, necessitating qualitative data gathering to complement the quantitative in order to create understanding. This is why a mixed method approach has been used in the research. This is done by making use of several data sources and types to alleviate some of the inherent biases in each data source or type (Greene et al., 1989).

#### 4.2.1 SCOPING AND SYSTEMATIC LITERATURE REVIEW

In this thesis two types of literature reviews have been used; scoping literature reviews and systematic literature reviews. In the identification of the main types of relational contracts and the subsequent definition of Partnering, Alliancing and IPD a scoping literature review was used. To conduct the scoping literature review the methodology applied follows the five steps laid out by Arksey & O'Malley (2005). Scoping reviews are done to rapidly map key features of a research area and the main sources in that particular field.

In the first step of a scoping literature review a relevant research question is formulated. As a next step a suitable search engine is used and in this particular case Web of Science was selected and relevant search terms are created. From the search in step three more refined search terms are created in order to reduce the number of irrelevant documents and create the study selection. In step four the data is charted. This was done using VOSviewer software to make a bibliographic coupling chart. In the fifth and final step the most strongly bibliographic coupled documents were analysed for Key Attributes of the relational contract types and the findings presented in tables.

The scientific literature visualization software VOSviewer has a bibliographic coupling tool which determines the connections and the strength of connections between documents in a corpus of search results (van Eck & Waltman, 2017). The strength of a connection is the number of cited references that publications have in common. This not only provides a clear picture of which publications are most strongly linked to others, but also emphasizes new review articles which have cited many of the core documents of the field.

To review relevant literature for the three journal papers each had a systematic literature review made. The process of conducting a systematic literature review has to contain three steps; database selection, search term iteration and result selection. Each step has its own key function and was done following the methodology in Thomé et al. (2016).

Database selection is a function of which databases contain relevant information and searching through databases without too much overlap, reducing the risk of getting duplicate results. Which databases the researcher has access to and how many, may influence the search, but in the case of the research presented, large and reputable scientific search engines were used, Web of Science, Scopus and EBSCOhost.

The search term is often presented as a single step, showing the final search term that yielded the results used in the literature review. This however hides the fact that finding good search terms is an iterative process. The search terms should be broad enough to capture all the relevant literature, without including too many irrelevant entries. When starting out, it is therefore important to start with a simple search term to get a feel for the variation in the results of the search. When this is done, more refined search filters can be added to make the final number of results fit the range that is useful. This range may be 20-30, if the intent is a very superficial glance at a field by identifying the texts that fit the specific search in a very narrow way. It could also be above 5000, if an entire field is looked at and all texts remotely relevant to the topic of interest needs to be included. Sometimes it is necessary to redo the search to include a search term, which in the first search was not used but in the subsequent study of the literature showed itself to be relevant. An example of this is the close relationship between strategic partnering and alliancing, both of which needs to be included to acquire a full picture of the field, if relational contracts in the construction industry is the subject of research.

After the search has yielded a number of entries deemed sufficient, several result selection steps are used to pare down the number of entries to the most relevant ones. First is the reading of the title of each entry to determine, whether the research paper, conference article or other scholarly work is relevant to the literature review. After all entries have been examined and the relevant ones identified by title, a second selection step is conducted using abstract reading to get a deeper understanding of the text.

As these steps are completed, a final list of scientific literature has been compiled and can be analysed. The three systematic literature reviews conducted as part of the PhD research presented in this thesis are on strategic partnerships, maturity models and business models.

#### 4.2.2 INTERVIEWS

The use of interviews in the research had two major functions. Firstly, they were exploratory and a way to get different perspectives on the renovation process, strategic partnerships, sustainability and business models from the practitioners in different parts of the construction industry. The themes and areas identified in the interviews could afterwards be explored further in literature, workshops or surveys. Secondly, the interviews could also be used to triangulate already established theory or answer a research question, and be used to support or refute a particular research conclusion.

With the purpose of the interviews being to gather data to illuminate unknown areas or topic as well as explore known themes, a semi-structured expert interview method was used. This interview method is described in detail in Kvale & Brinkmann (2014). Because the aim of the interviews were to get the personal experiences and interpretations, at every interview the interviewer made it clear that answers to questions or opinions should not be treated as true or false but as statements of the interviewee's personal observations.

All interviews started with a series of meta-data questions to establish the interviewee's identity, affiliation and experience in the construction industry. The subject of the interview had been disclosed to the interviewee in advance of the interview and the subject of the interview was structured into several categories of questions in an interview guide. The guide was not strictly adhered to, but all questions in the guide was sought to be answered and in many interviews other subjects apart from the predetermined were discussed at length. All interviews were recorded and transcribed either completely or partially. All transcriptions were naturalistic in order to preserve the tone and feel of the conversation.

#### 4.2.3 WORKSHOPS

The practice of creative group problem solving can be traced back to the 1940'ies and is the precursor to modern workshops (Treffinger & Isaksen, 2005). The use of workshops in a corporate setting is well established and several distinct concepts has been developed (Durance & Godet, 2010). The use of workshops in a scientific setting is however relatively new and as such, from a research methodology perspective, does not have a very secure foundation. This does not exclude it from a mixed method approach, where it can provide very valuable insights into how groups perceive and react to situations, as well as creating interplay between people, who under normal circumstances would not interact (Ørngreen & Levinsen, 2017).

This observation that a workshop is an artificially constructed social situation should also make a researcher using workshops critically assess the data collected from workshops. For this PhD



study a repeatable methodology to extract, document and analyse data was developed. The workshops were conducted as authentic and with the research data collection as a goal, with authentic meaning that the participants had a self-interested agenda when participating (Ørngreen & Levinsen, 2017). The research data was collected from the participants, in the form of post-it notes or filled in forms. This was supplemented by observations of the researchers participating or observing the workshops. From the planning phase of the workshops, goals were set in order to facilitate the data gathering. These could be goals like finding the value proposition components of business models as described by practitioners.

The workshops conducted as part of this PhD research is an amalgam of best practice, previous experience and inspiration from other scientific data gathering and analysing practices on other types of qualitative data. It can best be described as a note taking of a conversation by the researcher, crossed with a journaling exercise of the participants, crossed with a discussion and common sense making in the group.

The participants were in every case invited to the workshop with more than a months' notice, outlining the topic of the workshop. Prior to the workshop the researchers prepared models or frameworks, which were used during the discussions and as part of the data gathering process. At the start of the workshop, the facilitator would briefly introduce the topic and outline the concepts and frameworks to be used. The introduction was followed by a few rounds of either solitary work or work in small groups, after which the participants were invited to share their work and discuss. Depending on the topic or framework, this could be done in several iterations. Finally, the participants, individually or in groups, were asked to share their thoughts and the framework or model they had filled in. At the end of the workshop the researchers would collect the data produced by the participants together with own field notes.

#### 4.2.4 SURVEYS

To get results that are more general and to ensure that the sample data collected in interviews and workshops is not skewed by interviewer bias, a survey complements the qualitative data very well. A web survey, which was used in this instance, is a way of getting a large number of potential respondents that are not limited by geographical or institutional proximity to the researcher. It does however set some fairly large restrictions on which kind of data that can be retrieved, and the type of questions that are appropriate for a survey also limit the use of them. As a researcher, it is important to make sure that the questions are not obviously manipulative or will incentivise the respondent to respond in a certain way. It is however not possible to completely remove the bias, even the implicit one that the survey asks certain questions and omits others.

When using data from surveys, it is also important to recognise that there are a number of problems that are very hard to get rid of. The first is convenience sampling, where the respondents are convenient for the researcher to ask. The second is self-selection, where the respondents are only responding because they themselves want to. This excludes a number of potential respondents, because they are not driven to participate of their own volition (Bethlehem, 2010). While these biases exist and to a certain extend will colour the responses, the mixed method approach of the PhD means that other methods are used to evaluate the validity of the data. In this way, it is possible to triangulate valid data points and discard data that is not substantiated by other sources.

#### 4.2.5 CASE STUDIES

When studying complex subjects with many moving parts and aspects that can only be observed through natural experiments, case studies can be a potent data collection tool. Case studies can consist of one or multiple cases and can contain mixed method data collection (Eisenhardt, 1989). While the results are not necessarily generalizable, they provide a rich description of a subject matter and enables understanding of complex interactions. It is a method well-suited for theory building, and as such the focus is on choosing cases, which are likely to produce insights (Eisenhardt, 2007).

When using case studies as a data gathering method, one of the most central aspects to get right is therefore the case selection process (Flyvbjerg, 2006). In the research conducted for this PhD, two types of case selection methods were used. The first was an exploratory case study selection where it was important to get cases, where the data was from “ordinary instances”, the data was available to the researcher, and it should provide a general understanding of the area. It can be viewed as a scoping study (Arksey & O’Malley, 2005). The cases in an exploratory case study do not have to be exhaustive but rather give a common understanding, which can be used to provide direction for future research work.

The second case selection type used in the PhD research was an exhaustive case selection, where the case selection consisted of collecting all relevant cases within an area and using all of them in the analysis. This analysis will yield many different case types; outliers, differences and special cases, but for most areas of study, it is not practical. Case studies require a lot of description and in the case of renovation and construction projects with many participants, it quickly becomes prohibitively time consuming to make an exhaustive selection. The reason for using an exhaustive case selection was that there at the time were very few cases available.

### 4.3 EMPIRICAL DATA AND ANALYSIS

Because of the social nature of the research field, qualitative methods like research interviews, workshops and case studies were applied. To triangulate and validate/refute the results from the qualitative methods, more quantitative data collection methods have also been employed.

#### 4.3.1 WORKSHOPS DATA AND ANALYSIS

Data from workshops has been essential for the work presented in this thesis. From small groups of practitioners of eight to large groups of more than 40, the knowledge and insight gained from these interactions have shaped both the scope and direction of the project. In all, 21 workshops were part of the data collection, see Table 14. The majority of the workshops were conducted by the author and supervisors. In others, participation by the author was either as a participant or an observer.

To collect data at each workshop the participants were asked to fill out documents, which were sheets of paper with printed models or frameworks. An example could be a workshop exploring value propositions of AEC companies and building clients, where each participant was asked to fill out the Value Proposition Canvas (Strategyzer, 2020). To fill out the models or frameworks the participants used post-it notes to be able to write, move and rearrange input. When participants were asked to collaboratively fill out a single model, they were first asked to write ideas by themselves on post-it’s. This silent mode of brain storming was used to capture individual perspectives of the topics avoiding group biases and peer pressure. After a pre-determined amount of time, which could be three or five minutes, they were asked to discuss the input they had while placing the post-it’s on the model.

## **Workshop participants and scope**

The participants in the early workshops, which were used to scope the project and identify challenges, were from the societal partnership REBUS. They represented companies from the construction value chain; architects, consultants, contractors and material suppliers.

Representing the building clients were representatives from social housing organizations with portfolios of buildings. The focus was specifically on strategic partnerships and how this collaboration form would impact sustainable renovation projects.

The work in REBUS started in August 2016. The overall themes were to describe the common challenges and sources of waste in traditional construction procurement and processes, develop new procurement schemes and describe business models of the companies in traditional and collaborative procurement schemes. The work describing the traditional challenges in construction were conducted from fall 2016 to spring 2017. In May 2017 a collaborative public procurement framework supporting strategic partnership was published by REBUS (REBUS & DLA Piper, 2017). In collaboration with a law firm specializing in construction and public procurement, the documents were developed to support public building clients and building clients who are regulated by EU and national legislation when procuring building services like social housing organizations. The public procurement framework consisted of tender documents, a framework agreement and a guide to strategic partnerships. In 2017 and 2018, the group collected feedback and further developed public information material about strategic partnerships. Besides these projects, a number of activities related to development of business models were undertaken. Workshops utilizing different business model frameworks were tested and this work was the foundation for academic publications. The frameworks used were; Business Model Canvas and Value Proposition Canvas (Osterwalder, 2004), and the Four Block Business Model framework (Christensen et al., 2016).

As part of the work in REBUS a number of external collaborators have contributed to the work and development. These contributions have also aided the PhD research presented in this thesis. The Business Model Design Centre (BMDC) at Aalborg University utilized their online questionnaire to create a general analysis of the business model environment in the construction industry as part of the PhD research. The participants in REBUS filled the questionnaire and BMDC conducted an analysis based on the responses. The conclusions from the analysis were then presented and discussed at a subsequent workshop.

Practitioners with experience from strategic partnerships were also invited to workshops, both as participants and to give presentations. A practitioner from a public building client organization in Sweden with more than ten years' experience with strategic partnerships described their experiences with changing to a collaborative procurement scheme. The first strategic partnership in Denmark, created in 2016 invited the participants in REBUS to a workshop in their common workspace. This showed the participants, how the day-to-day operations of a strategic partnership with six companies and a building client working in one integrated space.

Since the work in REBUS was specifically targeted towards social housing building client organizations, a workshop was conducted with building clients from a number of social housing organizations, which were not participating in REBUS. This was done to get a broader perspective on the challenges and possibilities, which strategic partnerships have for social housing organizations.

To test the early prototypes of the work developed in the first phase of the PhD study, a workshop was conducted with practitioners from the building industry network at the Danish Architecture Centre in November 2016. The test led to a reframing and re-scoping of the work, which was invaluable to get at this early stage of the project.

Strategic partnerships and collaborative procurement in the construction industry in Denmark has seen a rapid increase in the last five years, and so have the interest from the research community in documenting and analysing this development. Several PhD projects have had collaborative procurement in construction as focus, including the one documented in this thesis, and a number of research efforts have been undertaken. One of these is the follow study of the building client organization at Copenhagen municipality (Gottlieb, Thuesen, Frederiksen, & Berg, 2020b). Data from a workshop conducted by the follow study with more than 25 practitioners from the construction industry was analysed as part of this PhD project.

To further develop the outreach and application of the concepts and knowledge generated by the PhD study and the work in REBUS, a collaboration with the organization VærdiByg was established. VærdiByg or “Value Creating Construction Process” is a co-operation between the six leading Danish construction sector organizations representing the entire construction value chain. The organization develops best practice information and guides to support the work in the construction sector. They develop this material using workshops and this work has been conducted with active participation from the author, both with presentations and as a participant (REBUS & Værdiby, 2021a; REBUS & VærdiByg, 2021b).

Table 14 Workshops that were part of the data collection for the PhD research

Theme	Participants**	Date	Duration (H:M)	Location
Workshop data used in procurement innovation paper (Berg et al., 2022a)				
Building law*	10	15-08-2016	4:00	Copenhagen
Collaboration tools in construction	25	30-11-2016	2:00	Copenhagen
SP Public procurement documents*	15	25-01-2017	4:30	Copenhagen
SP Public procurement document revision*	15	05-04-2017	6:00	Copenhagen
Public workshop event for the public procurement documents *	50	19-04-2017	3:45	Copenhagen
Energy performance validation in refurbished buildings*	20	24-05-2017	7:30	Copenhagen
Strategic partnerships in social housing	20	23-05-2018	4:00	Taastrup
Workshop data used in maturity model paper (Berg et al., 2022b)				
Maturity models	8	11-01-2017	4:00	Copenhagen
Challenges in construction	15	20-09-2016	5:00	Copenhagen
Relationship change when moving from market to hybrid governance	15	05-10-2016	3:30	Copenhagen
Changing procurement strategy from a building client perspective	15	26-11-2018	7:00	Lyngby
Possibilities and barriers to changing to hybrid governance	40	19-09-2017	7:30	Aarhus
Effects, instruments and boundary conditions in hybrid governance	25	11-12-2017	3:00	Copenhagen
Workshop data used in business model paper (Berg et al., 2021)				
Value of long-term strategic partnerships	15	23-05-2017	5:00	Copenhagen
Business models and strategic partnerships	10	21-06-2017	7:00	Copenhagen
Business development and strategic partnerships	10	20-11-2017	7:00	Copenhagen
Business models in construction	10	22-01-2018	4:00	Copenhagen
Strategic partnerships and building renovation	15	27-02-2018	1:30	Lyngby
Strategic partnerships	50	07-03-2018	1:30	Nyborg
Business model archetypes	15	16-04-2018	3:00	Lyngby
Strategic partnerships, possibilities and barriers	25	30-10-2019	3:00	Copenhagen

\* The workshop was not facilitated by the author

\*\* All participant numbers are the lowest number of participants that were present at any time during the workshop.

## Workshop data analysis

The researchers collected all the data and digitized the input. An example of data from a workshop can be seen in Figure 9.

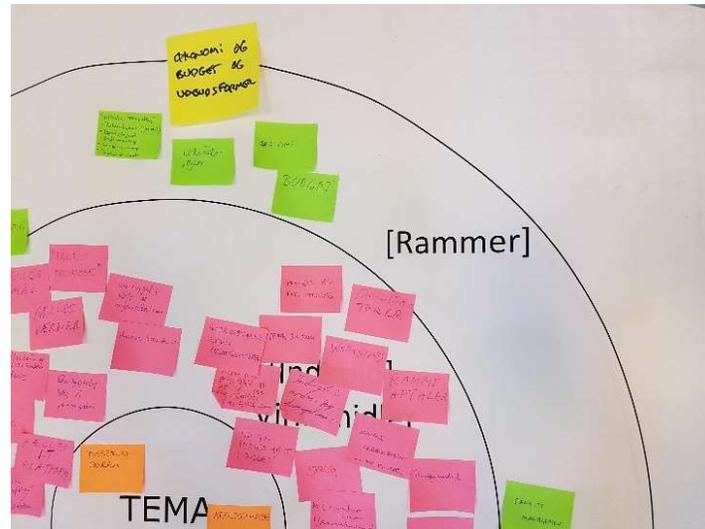


Figure 12 Example of data from workshop participants

From this analogue form, the data was inputted into a spreadsheet or word processing document depending on which type of analysis was appropriate.

One of the difficulties is that there is no established analysis procedure of the data (Ørngreen & Levinson, 2017). The data itself is also difficult to derive unambiguous conclusions from, since the data is from people interacting, and this interaction may or may not reflect realistic behaviour. This is why workshop data should always be used together with other sources and the analysis should be careful about the conclusions.

The great benefit of a workshop is that there is a possibility that the data from the workshop can send the research in a new and unexpected direction and it is possible to see many different reactions to a topic very quickly and follow this direction in a discussion. An example could be the attitude towards the problem of the fragmented supply chain with poor communication between the different stages, which leads to misunderstandings, poor decisions and friction, also referred to as the “over the wall” problem in literature (Evvuomwan & Anumba, 1998). It was quickly determined from the workshop discussions that there was a big difference depending, if the person were in the beginning of the construction phase or near the end. The people in the beginning did not recognise this as even being a problem, while the people at the end of the construction phases clearly recognized this as being a very common issue. It shows that while the people in the workshops may work in the same industry every day, the perceived reality may be very different and a workshop can be a great tool to expose these differences.

### 4.3.2 INTERVIEW DATA AND ANALYSIS

Interspersed with the workshops a number of interviews were conducted with practitioners. The eleven interviews with an average time of more than one hour had two overarching themes; strategic partnerships and business models. Conducted as semi-structured expert interviews, all of the interviewees had years of construction industry experience and were in management

positions. For each interview session, an interview guide was developed with a number of direct questions and themes of discussion. The reason for the semi-structured nature of the interviews is that the practitioners should be free to come up with new topics of discussion, and the interviewer/researcher should be free to pursue these if relevant for the project. The list of interviews can be seen in Table 15.

*Table 15 Interviews conducted as part of the PhD project*

Interviewee	Date	Duration (H:M)	Location
Interview data used in procurement innovation paper (Berg et al., 2022a)			
Architect	25-11-2016	1:23	Copenhagen, Denmark
Contractor	21-02-2017	1:26	Copenhagen, Denmark
Consultant	23-02-2017	1:31	Lyngby, Denmark
Social housing organisation	03-03-2017	1:37	Frederikshavn, Denmark
Producer of building materials	14-03-2017	1:23	Copenhagen, Denmark
Social housing organisation	29-05-2017	1:24	Aalborg, Denmark
Building law attorney	02-07-2019	0:34	Copenhagen, Denmark
Consultant	05-09-2019	0:44	Copenhagen, Denmark
Interview data used in business model paper (Berg et al., 2021)			
Contractor	18-06-2019	1:00	Copenhagen, Denmark
Producer of building materials	18-06-2019	1:30	Copenhagen, Denmark
Consultant and architect	19-06-2019	1:07	Lyngby, Denmark

In the beginning of every interview, the meta-data section made it possible to identify the interviewee as well as providing a couple of ways to analyse the data. These questions were:

- Do you want to remain anonymous?
- Is it possible to record this interview, for transcription?
- What is your name?
- What's your position?
- What is your (parent) company name?
- What is your professional background?
- How long have you been working in the construction industry?

From this initial set of meta-data questions, the interview continued with questions within two themes; strategic partnerships and business models.

In the interviews about strategic partnerships for the procurement innovation paper after the meta-data questions, the interview continued with the themes “Your interpretation of strategic partnerships”, “Which possibilities and challenges are there in strategic partnerships” and “What are the ingredients in a good building project?” The first theme was chosen to gauge, what prior knowledge the interviewee had about strategic partnerships. The second theme had the focus on the priorities and wishes the interviewee had to strategic partnerships and if there were

challenges when they looked at the strategic partnership procurement scheme. The third theme was to gauge what the interviewee saw as essential to execute a good building project.

Examples of questions:

- What is present in a building project where things are going well?
  - o Is it then the contracts, technical or personal relationships or something else that are the most important factors?

As these interviews were in the early phase of the research, they were also used to get a sense of how to fine-tune the proper interview technique. The interview guide was as such refined from interview to interview based on the responses from prior interviews.

The interviews regarding business models started in the same way as described previously with meta-data questions. As for the themes, they were “Business models in your company”, “Strategic partnerships and business models” and “Typical business models”. Under the headlines, a number of questions and sub-questions were used to prompt the interviewee to elaborate.

Examples of questions:

- What does the word business model mean in your company?
  - o Do you use other words such as business case, corporate mode, enterprise model, process model or similar?
  - o Who in your organization works with these

If any response seemed to reveal an interesting subject or a new area of information, at any time the interview could deviate from the scripted questions to explore this.

All the interviews were recorded and either fully or partially transcribed to facilitate the analyses of the data. The transcription was done naturalistically to ensure that as much of the natural dialogue was preserved. The method of creating meaning defined in Kvale & Brinkmann (2014) as the “ad hoc” method of creating meaning was used in the analysis. The interviews were not sought to be deconstructed, but read and listened through as a whole and then specific passages were studied in further detail. Since the open nature of the interviews meant that few overlaps in specific questions were present in the different interviews, the elements, which were analysed, were found through this approach.

An example of this is from an interview with a practitioner at a large contracting firm:

*“...neither we nor the suppliers are used to this, you are used to, quote unquote cheating each other [brief pause], so it is brand new when we come and talk strategic partnerships with the suppliers, uh they don't get it, uh and in the back of their minds all the time is; am I trying to cheat them?” - from Berg et al. (2022a)*



This quote is echoed by both other interview sources and literature (Eriksson, 2010). In this way the passage from the interview was triangulated which makes it more likely to be a common phenomenon.

### 4.3.3 SURVEY DATA AND ANALYSIS

To get a broader and more nuanced picture of what the Danish construction industry's attitude is regarding strategic partnerships a questionnaire was developed. The questions were based on the responses from workshops that were subsequently analysed and transformed into questions. To get a broad sample the survey was sent to the members of large Danish trade organisations, The Danish Association of Construction Clients, the Danish Association of Architectural Firms and the Danish Association of Consulting Engineers. The survey was also distributed to contractors and producers of building materials.

A second survey was created to get responses from practitioners, who had experience from strategic partnerships. These were sent to an email list containing management and upper management in the first two strategic partnerships in Denmark with the same public building client, Copenhagen municipality.

The responses from the two surveys were collected using the online platform Qualtrics and subsequently analysed. The total number of complete and valid responses collected were 36 responses from the first questionnaire and 17 from the second. The limited number of responses to the first survey should be seen in the light of strategic partnerships being a rather new phenomena in Denmark with the first two starting in 2016.

The first survey was designed to get a picture of what the respondents was expecting to happen, if they or a larger part of the construction industry started using strategic partnerships. There was also the goal of seeing, if the change would significantly impact the current practices in the companies. This is why nine questions in the survey was directed at their current tendering or procuring practices. For companies, who did not procure building services themselves, the questions were only directed at how they themselves were interacting with the companies or organisations procuring their products or services.

A total of 18 meta-data points for each respondent were collected from the respondents' web browser and interaction with the questionnaire. These data points were start time, IP address, duration, and distribution channel. The first seven questions in the survey were questions about the respondent and the company they worked for, like company name, role in the construction value chain, yearly turnover and position of the respondent in the company. Some of the questions were presented to the respondent as a dropdown menu with pre-determined options. In all cases, there was a possibility for the respondent to reply "Other" and in this case an additional free text box appeared for the respondent to type in other responses.

In the next nine questions the respondents were asked about the procurement practices that their company or organization use and/or are being subjected to. These questions were posed to determine the current state of practice and in this way juxtapose these answers to strategic partnerships.

In the final part of the survey, six common questions were posed to the respondents. These questions were asked to gauge what their attitude to strategic partnerships were and what they expected would be the consequences of this procurement scheme. The questions were asked as a number of statements, which the respondents would rate on a five-step Likert scale from

“strongly disagree” to “strongly agree”. This was done in an effort to enable the comparative analysis with the questions answered in the second questionnaire by practitioners working in a strategic partnership. To get additional data a “free text” field was provided to enable the participants to give their own answers to supplement the predetermined responses. The total number of data points can be seen in Table 16.

*Table 16 Data points from the survey about attitudes to strategic partnerships.*

Question type	Number of data points
Meta-data	18
Respondent questions	7
Tender specific questions	9
Common questions	6
Total	40

The second survey was distributed to 28 members of the two strategic partners and the building client. The 17 responses found to be valid equates to a 61 percent response rate. As the questions were answered using an online survey tool, 17 meta-data points were collected from each respondent.

To get a picture of who was responding to the survey eight respondent questions were asked. These were questions about the position of the respondent, his or her role in the strategic partnership and how long they had worked in the strategic partnership. The following six questions were common questions, which were used to do cross analysis with the responses from the practitioners, who did not have experience from working in a strategic partnership. The last eleven questions were related directly to the strategic partnership and the positive and negative aspects of this type of organization. The structure and data points can be seen in Table 17.

*Table 17 The data points from the survey on learning from strategic partnerships.*

Question type	Number of data points
Meta-data	17
Respondent questions	8
Common questions	6
Strategic partnership specific	11
Total	42

The data from the surveys was used to extract conclusions in several ways. While the number of respondents were not high enough to make determinations between the different types of

AEC companies, it was possible to do a comparison between the two surveys with the same questions given to different populations.

There were two types of response possibilities in the questions, which were posed to the two groups of practitioners. The first type was multiple choice using a five-point Likert scale, where a number of different statements should be scored. It was then possible to look at the relative importance each group gave the statement and see, if the other group gave the same relative ranking to the statement. Similarities as well as differences were noted for each of the six questions.

The second type of responses was the “free text” fields associated with each of the six questions where it was possible for the respondents to write if they had a response they did not feel matched the given possibilities. These were looked at to see if several respondents had written the same or similar responses in this field.

The survey was mainly used as a data source in the paper “Understanding transactions: A maturity model for construction supply chain relationships”, which is part of this thesis (Berg et al., 2022b).

#### 4.3.4 CASE STUDY DATA AND ANALYSIS

Case studies were used in two parts of the research; in the beginning an exploratory case study was completed to create a vocabulary about strategic partnerships. The second was a complete case study, which was used to define what became the Danish model of strategic partnerships.

In the first case study, two main cases were used and the study was performed as a desk study. The data was from existing sources; one on the strategic partnership of Salford City Council in the UK and the other was from Telge Fastigheter in Sweden (Kadefors et al., 2013, Mallinder, 2006). The similarities and differences in the two cases were analysed.

The results of the case study was published in the conference paper “Prerequisites for Successful Strategic Partnerships for Sustainable Building Renovation” at the 9<sup>th</sup> Nordic Conference on Construction Economics and Organisation in Gothenburg, Sweden, in 2017 (Jensen et al., 2017). This paper was a stepping stone towards the paper on procurement innovation (Berg et al., 2022a).

To get an understanding of the strategic partnerships in Denmark, a second case study comprising the first four strategic partnerships in Denmark was conducted in 2018 and 2019. The case study comprised the public available procurement documents from the two strategic partnerships started by the Copenhagen municipality in 2016 and the two strategic partnerships by the social housing organizations, fsb and KAB started in 2018. Interviews with participants, site visits, surveys from practitioners and presentations by practitioners from the strategic partnerships were all used to collect data and information from the partnerships.

The results from the case study was the definition of the Danish model of strategic partnerships described in detail in section 6.1 and in the procurement innovation paper (Berg et al., 2022a).

The first case study used documents from various sources. The analysis was used to explore strategic partnerships in UK and Sweden and create a vocabulary about strategic partnerships. Exploring desk case studies is very useful since it is possible to quickly get insight into a topic, which may otherwise be impossible to get physical access to. The drawback is the reliance on available documented cases and presentations and limited possibility to make further inquiry

from the primary source. The analysis looked at differences and similarities between UK and Sweden and from this develop an understanding of what to look for in a Danish context.

The second case study analysis was on the procurement documents developed to tender strategic partnerships in Denmark. In this case the main centre of comparison was the public procurement framework developed by the social partnership REBUS, specifically the framework agreements (REBUS & DLA Piper, 2017). To do the analysis both quantitative text comparison and comparison of the individual sections of the framework agreements were made. It showed how the bespoke contracts made for the building client organisation at Copenhagen municipality were transformed into a generic format suitable to public building clients. It then focused on the two strategic partnerships made by two Danish social housing organisations, fsb and KAB, and analysed their framework agreements. Using the same technique as in the exploratory case study similarities and differences were explored.

The results show the commonalities, which can be argued are the foundation of the Danish model of strategic partnerships, and are presented in the procurement innovation paper (Berg et al., 2022a).

#### 4.4 RESEARCH TRIANGULATION

To ensure results and conclusions that are reproducible and have sufficient validity, triangulation of results is a popular method in the qualitative research fields (Carter et al., 2014). Triangulation is a method, where multiple data sources are used to create a comprehensive understanding of phenomena and there are several ways of conducting triangulation (Patton, 1999). In this PhD research and analysis, method triangulation has been used and to a lesser degree investigator triangulation. The reason for the number of different data acquisition methods described in the previous sections is to support method triangulation analysis.

A number of criticisms have been levied against triangulation in qualitative research. One such criticism is that each data collection method has its own way of creating knowledge and insight about a phenomenon and that comparison of results should be done carefully. The eclecticism evident in triangulation is not a feature, which the critics find appealing. An argument has been that triangulation rather than providing validation and an objective interpretation, more is a strategy to provide a deeper understanding (Flick et al., 2004). Since the research presented in this PhD thesis focuses on model development, this deep understanding is essential. As with the use of case studies, the purpose of science is not only to validate but also to develop, which is the exact focus of this PhD work.

In general, the mixed method approach, which was used throughout the research, has meant that no data source has been singularly relied upon to draw conclusions. This data source triangulation should increase the chances for valid and reliable results (Carter et al., 2014).

The following triangulation example is a step in the creation of the Key Attribute matrix of the maturity model developed in the paper about procurement maturity (Berg et al., 2022b). The goal was to triangulate if a specific value criteria should be included in the final Key Attribute matrix. The value criteria "Collaboration" was identified in three different sources during the data analysis, all showing it as a credible candidate from the Key Attribute matrix.

The first data point is from a workshop and the full list of workshops used can be seen in

Table 14. “Collaboration” was first found in the analysis of the data from the “Effects, instruments and boundary conditions in hybrid governance” workshop, where “collaboration” was mentioned by several workshop groups. It was found in the survey data, from practitioners with and without experience with strategic partnerships, in the form of the term “Better collaboration”, which was in the top five responses to the question “A strategic partnering can create...” in both respondent groups. It was found as a “Main Criteria” in the Key Attribute matrix in the SCR maturity model (Meng et al., 2011). This makes three different sources all mentioning “collaboration”, making for a very strong case for this value criteria to be included in the maturity model developed in the paper.

A contrary triangulation example can be found in the same development effort of the Key Attribute matrix for the maturity model. In this case the triangulation meant that a sub-criteria from the SCR maturity model had to be discarded. In the SCR maturity model developed by Meng et al. (2011) there is a sub-criteria called “Continuity of work” where the sub-criteria description on level four is “Guarantee for future work” for strategic partnering. In the analysis of the data from the workshop “Stability” was identified as a value for the AEC companies. This was data from the workshop called “Effects, instruments and boundary conditions in hybrid governance”. This is then two data points suggesting that stability or continued work should be part of the Key Attribute matrix. However in the analysis of the data from the survey with and without experience with strategic partnerships this inclusion could not be supported. When asked what effect participating in strategic partnerships would have for the companies, the practitioners with experience from strategic partnerships put “stable income/costs” as the second last in their judgement of likely outcomes. This does not mean that strategic partnerships cannot be a source of stable future work, but it has been disputed by a credible data source. In this case to make sure that the developed maturity model had complexity and value criteria which had the strongest support from the available data, the “Continuity of work” criteria was excluded.

#### 4.5 RELIABILITY AND VALIDITY

For each of the data sources used in the research presented in this PhD thesis, different techniques were used to insure reliability and validity. It has not always been a straightforward process, since some of the data sources, while valuable, do not have robust analysis standards. Steps were taken to reduce the bias and increase the likelihood of obtaining valid data.

Making a systematic literature review means that some areas are deliberately chosen and others excluded. The chosen databases do not contain all relevant knowledge, and the search terms will inevitably exclude relevant material. To mitigate this, three databases (Scopus, Web of Science and EBSCOhost) were used and the search terms were kept broad, and thousands of results were examined for each literature search. Furthermore, in the reading of the relevant papers, there were a conscious effort to identify common references in the papers that could be of significance to the research. Supplementary literature apart from the systematic literature reviews were also used to make a broad base of knowledge from which to draw conclusions. This additional literature was from conferences, recommended by other researchers or from reading trade publications.

Workshops as a means to gather empirical knowledge and the analysis of the data is not rigorously defined (Ørngreen & Levinsen, 2017). To make the data from the workshops as

useful as possible, the researchers used fairly simple workshop formats and simple analysis techniques. The data analysis and conclusions from the workshops were validated both through investigator triangulation and presentation to and comments from the workshop participants. The conclusions from the analysis was always critically reviewed and compared to conclusions arrived at from other sources, like interviews, literature or surveys.

The interviews were conducted in an informal format, where the interviewee was free to respond to a question in the way that felt most natural to him or her. It is impossible for the interviewer to not influence the subject of the interview in some way, and the framing of the conversation has an influence. It is not possible to get rid of the “interview effect” (Al-Yateem, 2012), but to mitigate this somewhat, the interviews were always conducted at the interviewees place of work and in neutral settings like conference rooms. This was done in an effort to get as close to a normal situation for the interviewee as possible and interviews were always preceded by information about the interview and a briefing of the interviewee at the start of the interview (Kvale & Brinkmann, 2014). In the subsequent analysis, the focus was on the description the interviewee gave of their own experience. This description was then examined against other descriptions from literature, surveys and workshops.

A survey has many advantages when it comes to collecting and analysing a large number of responses. It does however come with a number of drawbacks. The type of questions asked and the possibilities of answering said questions, will affect the responses. In an effort to remove some of the bias from the process, the questions were designed using responses from practitioners at workshops, and the questionnaires were through several rounds of validation, where practitioners were asked to fill out preliminary versions and comment on the survey.

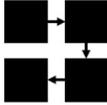
The use of case studies to give a rich and nuanced perspective is a well-established method. It does however have restrictions in terms of generalizability. In the research, the exploratory case study were used in the early phase to get a vocabulary about strategic partnerships, as well as getting examples of how they have been implemented. This does not give a full picture of the subject and was combined with other data sources. The exhaustive case study, where all relevant cases were used, was a way to establish a more strict definition of a single instance of strategic partnerships, which was called the Danish model. In this case, generalizability was not a focus since it was the particular arrangement of attributes that these strategic partnerships had and shared that was important.

## 5 THEORETICAL PERSPECTIVES

The three major theoretical perspectives in this thesis are transaction costs, maturity models and business models. While the thesis has five theoretical context themes as shown in Figure 3 and section 1.3, procurement innovation and relational contracts are handled in a different way. The relevant procurement innovation in the context of this thesis is relational contracts. The definition of relational contract types are shown in the scoping literature reviews in section 2.1 and the results are shown in section 6.4. Archetypes and friction are described in sub-section 5.3.1 and 5.3.2 respectively.

In Table 18 the theoretical perspectives of each of the three papers can be seen.

Table 18 Theoretical perspectives used in the three papers that are part of the PhD research

	Transaction	Building client	AEC companies
			
Reference	(Berg et al., 2022a)	(Berg et al, 2022b)	(Berg et al., 2021)
Theoretical perspective	<ul style="list-style-type: none"> <li>• Procurement innovation</li> <li>• Relational contracts</li> </ul>	<ul style="list-style-type: none"> <li>• TCE</li> <li>• Maturity models</li> </ul>	<ul style="list-style-type: none"> <li>• TCE</li> <li>• Business models</li> <li>• Archetypes</li> <li>• Friction</li> </ul>

In the following sub-sections, the history and influences of the three areas of theory are described.

### 5.1 TRANSACTION COSTS

Understanding what the drivers of cost are in a company is one of the fundamental and seemingly trivial areas of analysis, when it comes to understanding how a company functions. In a simple production line, there are material costs, labour and the cost of managing HR, accounting, IT and similar support functions. But it is an area that until the work of Oliver E. Williamson in the 1970'ies was not defined as a research field. This changed with the introduction of Transaction Cost Economics (TCE).

Transaction Cost Economics was not developed in a vacuum and can trace its roots back to very old concepts like friction, see sub-section 5.3.2. The goal of this early work was to make a description of why some transactions were associated with costs and why some transactions were subject to suboptimal performance and behaviour of companies or individuals. To explain why economic theories failed in certain circumstances, friction was introduced as a concept, but not developed to a separate area of research (Hardt, 2009). While Oliver Williamson was not the first to describe transaction costs, he was the first to coin the term Transaction Cost Economics in his 1979 paper "Transaction-Cost Economics: The Governance of Contractual Relations".

Central to Williamson's research was the question of "make vs. buy" or how to optimally structure a company to take advantage of the market and where appropriate have "in-house" production. Williamson identified these two as the poles on a spectrum and then created the analysis framework to look at the hybrid modes of governance between these poles. He found it puzzling that most transactions in companies fell into one of these two extremes and that there might be room for more hybrid modes of transactions (Williamson, 1979). In his work on TCE Williamson identifies four relationship types; market, bilateral, trilateral and unified governance.

Another central theme in TCE is uncertainty and Williamson makes this very clear:

*"Transactions conducted under certainty are relatively uninteresting. Except as they differ in the time required to reach an equilibrium-exchange configuration, any governance structure will do."* (Williamson, 1979)

If there is certainty, it does not matter if a market, hybrid or a hierarchical governance structure is used. The only difference is how fast an equilibrium is reached between the transacting parties. When looking at this from a construction or more specifically a building renovation perspective, it becomes clear that simple market transactions become very inappropriate:

*"...a more elaborate arbitration apparatus is apt to be devised for occasional, nonstandard transactions. And bilateral governance structures will often give way to unified ones as uncertainty is increased for recurrent transactions."*  
(Williamson, 1979)

As building renovation and in particular energy renovation almost by definition are occasional and non-standard, suitable complex governance and contract structures should be used. The most simple relationship or governance structure is the market. This structure contains three core principles; a market place for mediating transactions, legal frameworks and remedies, and standardized contracts (Colledge, 2005). To interact in a market, the products need to be standard or in Williamson's terminology "non-specific", they need to be fairly simple to determine the quality of and the market needs to contain many buyers and sellers.

In trilateral governance or using neo-classical contracts, steps are taken to reduce the reliance on legal remedies and to solve conflicts outside the legal system. This is done when products become more complex, but the interaction frequency cannot support the cost of a more elaborate governance structure. The cost of trilateral governance should be seen not only as monetary, but also in terms of changes to the organisation, processes, strategic focus and more. For many types of transactions with low frequency, it is not possible to invest the amount of resources necessary for a more elaborate governance structure and in these cases a trilateral governance structure makes the most sense.

In bilateral governance, identified as a relational contract type in TCE, the conflict resolution schemes from trilateral governance is preserved and further measures are taken to enable the organisations to handle conflicts and uncertainty. The contract contains mechanisms for limited renegotiation by the organisations, if external factors makes this necessary. As a governance structure bilateral governance is the newest and least understood (Williamson, 1979).

The fourth and last is unified governance or the hierarchy. In this governance mode, all transactions are mediated by a corporate structure. In this way, there is less friction in the transaction and a great alignment of goals, since all parties are in the same organisation. The



hierarchy does however have its own sets of challenges like the free rider problem, where it can be difficult to ascertain if a team member in a part of the organisation actually contributes value (Williamson, 1981).

Because each governance mode has its strengths and weaknesses, Williamson advocates for a thorough examination of each transaction to determine the optimal governance structure.

## 5.2 MATURITY MODELS

Maturity models have since their inception in the early 1990's been used to guide public procurement (Rendon, 2008). The first maturity model developed, Capability Maturity Model (CMM), was created to support the assessment of vendors tendering public software development projects (Paulk et al., 1993). In the following decades maturity models have been used to evaluate the maturity of processes in many industries (Iversen et al., 1999, Santos-Neto & Costa, 2019). Maturity models in general consist of two parts; a graphical representation of maturity levels and an analysis matrix. It is in the graphical representation that the two main types of maturity models can be distinguished; lifecycle perspective or potential performance perspective (Wendler, 2012). Generic examples of the two types with four levels can be seen in Figure 13. In general maturity models are created with between four and six levels of maturity.

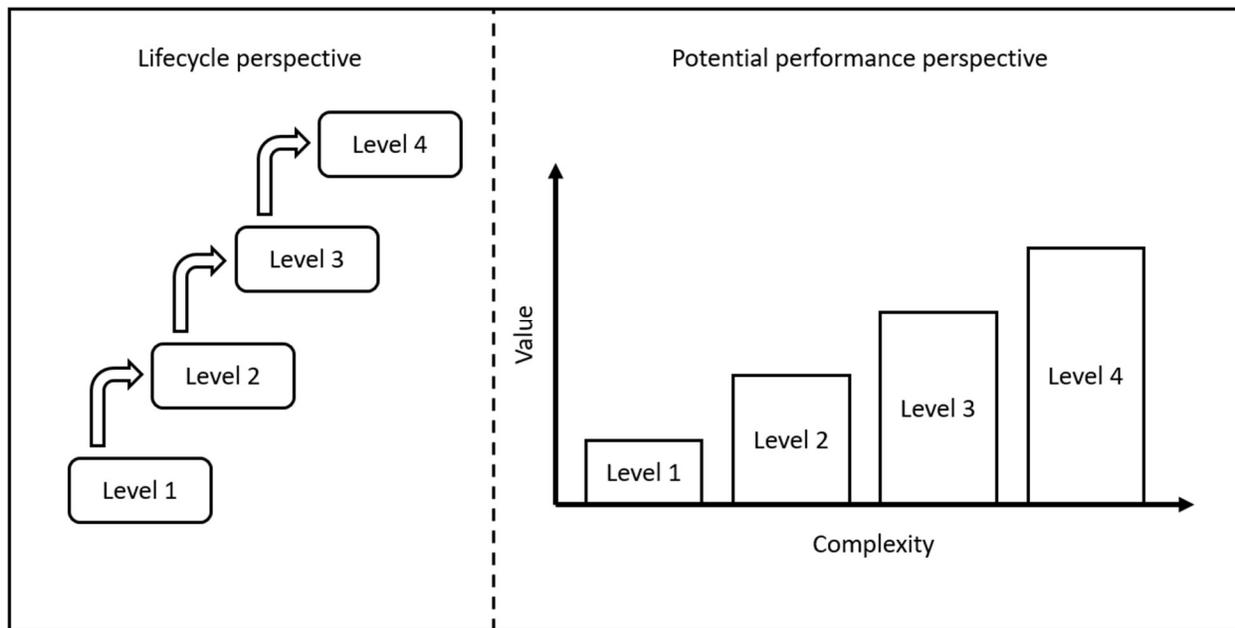


Figure 13 Generic graphical elements of maturity models with lifecycle and potential performance perspectives.

The graphical representation of the classical lifecycle perspective only has one axis and as the process matures over time with repetition it naturally moves to a higher maturity level. In the potential performance perspective there are two axes and the progression from one level to the next is done deliberately to take advantage of the benefits gained from a higher maturity level. The benefits of a higher maturity level comes with added complexity of the process and as such this complexity will only outweigh the benefits in certain circumstances. As such the two types of maturity model perspectives model very different processes.

A maturity models second part, the analysis matrix, contains the various aspects that change as a process matures. The matrix can contain Key Attributes, Key Process Areas or Key Performance Indicators depending on the model (Paulk et al., 1993, Wendler, 2012, Santos-Neto & Costa, 2019). They are used both to ascertain the current maturity level and can be used as a guide to improve maturity. As such the maturity model can be used both as a tool to assess an organisations maturity and to help in developing more mature processes. In the potential performance perspective this evaluation should be done with respects to the value and complexity dimension, and it will not in all cases be advantageous to make a process more mature.

### 5.3 BUSINESS MODELS

A business model is as the name suggests a “model” of a “business”. It is a way to describe the resources that are available to an organization, and what transaction cost optimizations create value for the customer and the company (DaSilva & Trkman, 2014). A business model is in essence a model of a business that explains core features of the business (Magretta, 2002, Teece, 2010). All companies can be modelled in this way, but it is not necessary for a company to articulate its business model (Chesbrough, 2006). As such, a business model is not created to fully describe the myriad of social, technical or economic interactions, which are the full description of a company, but rather a simplified model created for analysis and strategic decision-making. The connection to TCE become clear, when the history of business models is examined. The rise of the use of business models came with the internet and e-commerce, which was a way for companies to drastically reduce transaction costs (Bunduchi, 2008). The creation of value from a combination of resources grounds business models in theory developed by Schumpeter (1934), while the TCE perspective also recognizes the value of transactions as a driver of value creation (Morris et al., 2005). Using these fundamental principles, many frameworks have been developed to assist practitioners and academics create business models for specific businesses.

Business models became very popular in the late 1990’ies especially in the area of Venture Capital, where companies with innovative business models were seen as being more attractive investment opportunities for venture capitalists and investors (Franke et al., 2008). They soon became an area of scientific study and several business model frameworks were developed not only to support practitioners and the scientific community but as tools for analysis (Osterwalder, 2004, Fielt, 2013, Christensen et al., 2016). These business model frameworks focused on several dimensions of analysis. A dimension central to most, is the company’s “Value proposition”. This is the central product or service, which the company promises to deliver to the customer. An example of an analysis is how new products or services will change the value proposition. It is then possible to evaluate several scenarios for future company performance. The same type of analysis can be done for each dimension in the business model. When a company’s business model has been described, it can also be evaluated with respect to other business models from other companies. This can show synergies or friction that can explain why some companies for instance merge with ease or why a company is unable to access a certain market.

In the PhD research, the framework for creating business models called the Four Block Business Model framework (FBBM) developed by Christensen et al. (2016) was used. The FBBM together with frameworks like the very popular Business Model Canvas developed by Osterwalder (2004) were also used in data collection. When working with practitioner

interactions the FBBM framework has several advantages. A simplified version of the FBBM framework showing the development steps can be seen in Figure 14. Firstly, it uses four dimensions of analysis as opposed to the nine used in the Business Model Canvas, which makes the FBBM simpler to work with when using data from practitioners. The FBBM also has a time dimension built into the framework, where the development of the business model is in the order from value proposition over resources to processes and in the end profit formula. This means that in the framework there is a very structured way to develop new business models and an understanding that a change in value proposition needs to be the first centre of attention, when developing a new business model. The second step is to make sure that the right resources are present to fulfil this value proposition. After the resources have been secured the processes to effectively utilize the resources needs to be defined. It is first after these three steps are completed that a profit formula can be articulated.

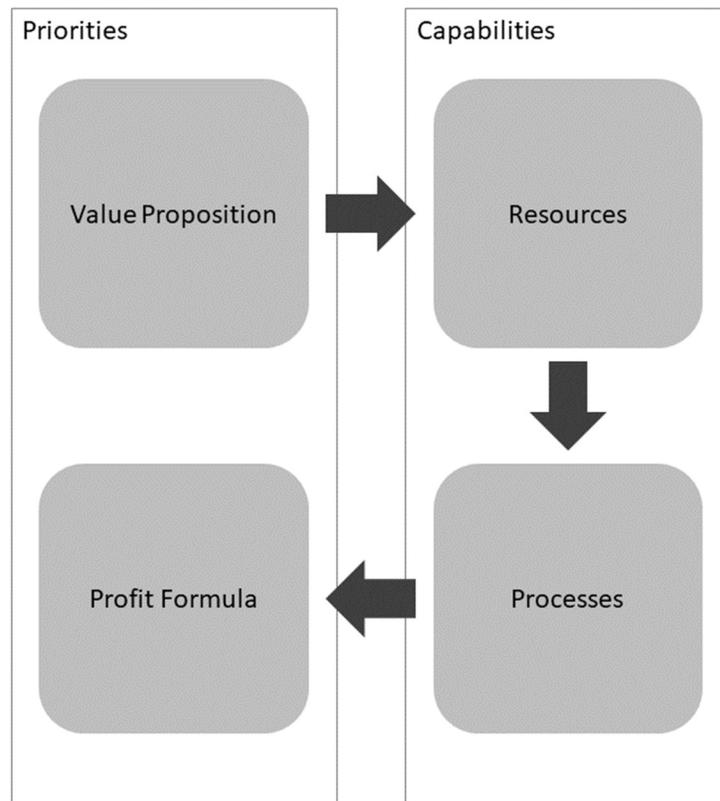


Figure 14 Simplified version of the FBBM framework developed by (Christensen et al., 2016)

To make the analysis of the AEC companies it was found that the development of archetypes were a key stepping stone. Using these business model archetypes it was possible to make friction analysis to discover issues when making changes to the construction value chain as in the case of making a strategic partnership. Archetypes and friction are the last two of the five key concepts described in this chapter.

### 5.3.1 ARCHETYPES

The concept of archetypes and the ideas behind the modern use of the term can be traced back to Greek philosopher Plato and his “Eidos” (Williamson, 1985). In the classic texts the “eidos” or

ideas are the idealized or pure versions of an object. From Plato's Republic, book 10, the following quote shows this:

*"We are in the habit, I take it, of positing a single idea or form (eidos) in the case of the various multiplicities to which we give the same name . . .; for example, there are many couches and tables. . . . But these utensils imply, I suppose, only two ideas or forms (idean), one of a couch and one of a table"*  
(Williamson, 1985, page 95)

As a research tool archetypes are still developing both in terms of methods and tools (Sietz et al., 2019). Both quantitative and qualitative data gathering and analysis can give rise to the creation of archetypes. The level of analysis of the archetype is attractive in many cases since:

*"... [archetypes] advance comparison and generalization at an intermediate level in between the particularities of single cases and panacea perspectives."*  
(Sietz et al., 2019, page 13)

Archetypes have been used extensively in modern business model research (Brown, 2018, Rosa et al., 2019, Hodapp et al., 2019, Palmié et al., 2021, Pieroni et al., 2020). Creating archetypes is a way to abstract key characteristics away from an individual company and in this way disentangle the characteristics from the individual contexts of the companies. In this way it is possible to look at trends in business models, find unique differences when comparing business models and help show the landscape of business models for practitioners and academics. Business model archetypes also aid in further analysis and development of business models, policy decisions and a number of other practical applications. Rosa et al. (2019) concludes the following in their paper on Circular Business Models (CBM) archetypes:

*"From a governmental perspective, detected CBM archetypes could guide politicians in drawing up circular-based plans and subsidies. From an academic perspective, they open new research opportunities."* (Rosa et al., 2019, page 14)

Business model archetypes have also been used to analyze the retrofitting of residential buildings (Brown, 2018). Here the archetypes can be used to explain existing market conditions:

*"The paper has identified five archetypes that are currently being used for residential retrofit within the EU, compared them in terms of their value proposition, supply chain, customer interface and financial model and overall BM governance and showed how differences in these elements can help explain their relative potential in delivering comprehensive residential retrofit."*  
(Brown, 2018, page 1512)

### 5.3.2 FRICTION

In economic literature the concept of friction is very old. In the earliest accounts describing transactions this friction is physical in nature, e.g. transportation of goods to a marketplace (Aristotle [350 BCE] B. Jowett, 1999). The concept of friction has in modern economic theory been expanded to information (Hardt, 2009). There is a clear relationship between the broad concept of friction and Transaction Cost as seen in this quote from Oliver Williamson:

*“In mechanical systems we look for frictions: do the gears mesh, are the parts lubricated, is there needless slippage or other loss of energy? The economic counterpart of friction is transaction cost: for that subset of transactions where it is important to elicit cooperation, do the parties to the exchange operate harmoniously, or are there frequent misunderstandings and conflicts that lead to delays, breakdowns, and other malfunctions?” (Williamson, 1989, page 142)*

When a company is faced with a change in business model this is also associated with friction. It can be a difficult process to make a smooth transition to a new value logic and internal conflicts over resources can make the change happen slowly or not at all (Kim & Min, 2015).

*“...previous studies have assumed away the performance implications of conflicting assets by taking for granted that a new and superior technology replaces incumbent firms’ old technology with little friction. Yet, this implicit assumption misses the important quandary an incumbent faces when attempting to manage its old business model and new business model simultaneously” (Kim & Min, 2015, page 35)*

Using friction to analyze change in business models both internally and between business models in construction can provide insight into the problems associated with reconfiguring the construction value chain.

## 6 RESULTS

The primary research output from the PhD research are three scientific papers and the results from them are summarized in the following sections. In addition to these results a separate section on the taxonomy of relational contracts have been made based on the literature reviews and comparison of the main types of relational contracts and strategic partnerships.

### 6.1 THE DANISH MODEL OF STRATEGIC PARTNERSHIPS

The first of the three papers, see appendix A, is on procurement innovation and titled:

*“Procurement innovation as a vehicle for sustainable change – A case study of the Danish model of strategic partnerships”* (Berg et al., 2022a)

As part of the research effort, one goal was to identify and quantify exactly what was new and innovative in strategic partnerships. In this effort, it quickly became clear that there are several definitions, when it comes to terms like strategic partnerships, strategic collaboration and strategic partnering (Bresnen, 2010, Jensen et al., 2017, Kadefors et al., 2013, Sundquist et al., 2018). To mitigate this confusion in terms and definitions the paper identifies what is termed “The Danish” model of strategic partnership (Berg et al., 2022a). The definition is established by focusing on the procedures making the strategic collaboration and not the outcome, which was identified as a research gap (Eriksson, 2010). The name does not imply that this is the only way of collaborative procurement occurring in the Danish construction industry, but that this specific constellation of contracts and attributes have become a replicated standard in Denmark.

An abbreviated version of the definition of the Danish model of strategic partnership can be surmised in the following way:

- A tender or procurement process based on primarily qualitative evaluation criteria.
- Joint Ventures of AEC companies as the strategic partner to the building client.
- Based on a framework contract with 4+ years of duration.
- A bilateral governance structure with strategic, tactical and operational levels.
- Common goals and values between the building client and the strategic partner.
- Open books.
- Conflict resolution based on a multiple step escalation system with litigation as the last step.

From the list above, it is clear to see that the Danish model has many similarities to other types of relational contracts and in particular, the strategic partnering schemes that have been used in Sweden and the UK. This is not surprising, since the development of the Danish model is based on these models with inspiration gathered from both countries.

The Danish model was developed in three distinct phases from 2016 to 2019. In the first phase, a large building client organisation, Copenhagen municipality’s building client organisation, created a bespoke contract setup, with the characteristics detailed in the list above.

Subsequently the societal partnership REBUS made a public procurement framework, which created a public procurement standard using the same principles, but made the procurement framework organisationally agnostic. In this way, any Danish building client organisation was able to use this framework to tender strategic partnerships. The third phase was two social housing organisations, fsb and KAB, employing the public procurement framework developed by REBUS to tender strategic partnerships. This was two full-scale tests with building portfolios with an expected value of above 300 million euro. By analysing this development, it is possible to argue that a Danish model for strategic partnerships has been created.

It should be noted that the Danish building procurement regulation and the standard contracts generally agreed upon by industry stakeholders in Denmark does not directly support strategic partnerships. The public procurement framework is as such a bespoke contract, which incorporates standard Design-Build contracts. All four strategic partnerships have also used the same legal firm to make the final contract for the tender and framework contracts.

The elements from the Danish model can be found in the literature on strategic partnerships but with many focused on the building client and the contractor forming a dyad and not Joint Ventures of AEC companies (Bygballe et al., 2010). In other descriptions of strategic partnerships the focus is on the social aspects and the relationships, which are not governed by contracts, and that the relationship has grown organically over time (Kwawu & Hughes, 2005). As has been found in previous work on the subject, there is a very large number of definitions and a general lack of strict rigorous definition of strategic partnerships. The Danish model is an attempt to give one such description of a realized and replicated strategic partnership procurement scheme.

## 6.2 WHEN TO BUY USING WHAT?

The second paper, see appendix B, focuses on how a building client or company procuring building services can use different procurement strategies. The title of the paper is:

*“Understanding transactions: A maturity model for construction supply chain relationships”*

In a situation where new paradigms and possibilities arise in an industry, one central question faces every company and organisation. What, if anything, do we change?

The maturity model developed and presented in the paper is a model created to answer this question. Using four levels, the model takes the perspective of a building client or an organisation procuring building services. To evaluate the four levels there are two dimensions, value and complexity. The four levels are from least complex to most complex; price, quality, project partnering, and strategic partnering. The four names for the maturity levels are identical to previous models that have looked at procurement maturity in construction (Meng et al., 2011). In this way the model developed in the paper has a direct link to existing literature and models. The graphical representation can be seen in Figure 15.

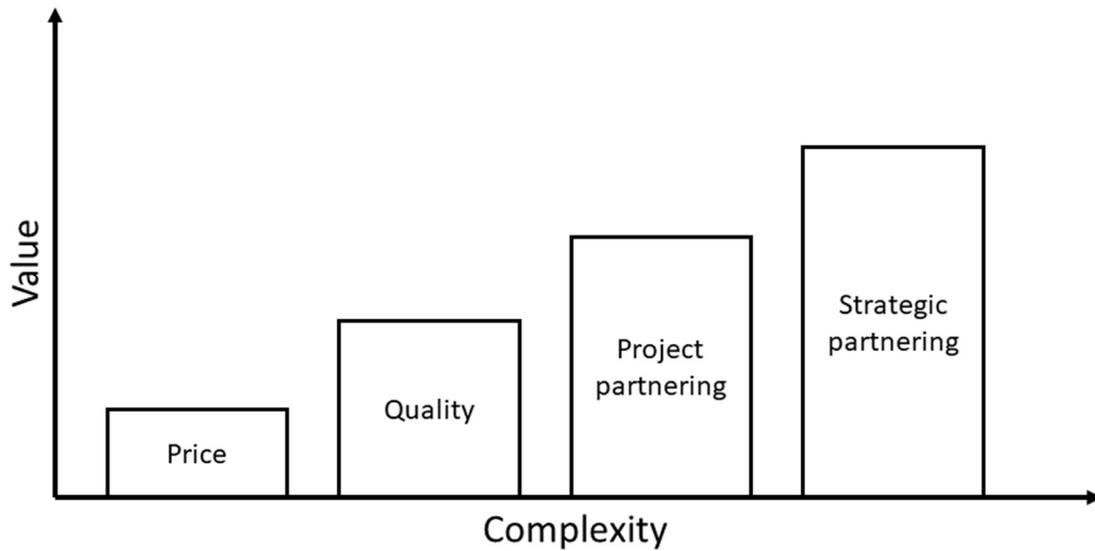


Figure 15 The graphical part of the Construction Supply Chain Transaction maturity model from (Berg et al., 2022b)

In the model, the core rationale is that with each buyer-supplier relationship there is a certain potential for value creation and an attached complexity, which needs to be addressed. With a higher level of maturity, there is an associated value that can be gained, and an increased level of complexity that needs to be handled. Each maturity level has intrinsic value and as such a higher maturity level is context and transaction dependent. The second part of the Construction Supply Chain Transaction (CSCT) maturity model is an analysis matrix to evaluate the transactions, seen in Table 19.



Table 19 The analysis matrix of the CSCT maturity model from (Berg et al., 2022b)

Dimension	Criteria	Level 1	Level 2	Level 3	Level 4
		Price	Quality	Project partnering	Strategic partnering
Value	Holistic risk management	None	Low	High – short term	High – long term
	Trust	Contract	Contract and capability	Common incentives short term	Common incentives long term
	Collaboration	None	Low	Common decisions	Common culture
	Cost transparency	None	None	Open books	Open books
	Development	None	Low	High on single project	High on project portfolio
	Integration of teams	None	None	Possible	Assured
	Conflict resolution	Contract and judicial	Contract and judicial	Conflict resolution framework	Conflict resolution framework
Complexity	Procurement strategy	Simple	Nuanced	Developed	Integrated
	Transparency in award criteria	Simple	Nuanced	Qualitative	Qualitative
	Power dynamics	Simple Adversarial	Nuanced Adversarial	Collaborative with few stakeholders	Collaborative with many stakeholders
	Senior management involvement	Low	Low	Medium	High
	Building client competences	Low	Medium	High	Very high
	Communication	Contract	Contract and criteria	Joint communication	Joint communication
	Benchmarking	The market	The market and value of criteria	Open books and value of criteria	Open books and value of development

Each level in the maturity model has both value and complexity associated with it. At level one, being the simplest relationship, is a relationship based on price. The reasons for using this strategy are numerous and can be identified by using the analysis matrix associated with the maturity model. At its core is that it is simple. It requires no prior knowledge of the building industry to explain who got the contract and why. It is easy and as a procurement strategy it is

used in every organisation. This makes it a strategy that everyone is familiar with and does not need defending.

On the second level, the procurement strategy is based on quality. This means that together with price as a contract award principle other measures are used to ensure quality requirements. In the EU language of procurement, this is known as Most Economically Advantageous Tender (MEAT). Using this type of tender means that the building client needs to be able to evaluate bids from suppliers, which have qualitative measures, and needs to do this in a fair and transparent way. It requires a building client organisation that is more mature, but does not involve some of the more fundamental changes to the organisation, which the following maturity levels have.

At level three, the first relational procurement scheme can be found; project partnering. In project partnering bilateral governance structures are created to give joint decision power between the building client and the AEC companies. This means that the building client relinquishes some direct control but in return gets insight into the inner workings of the AEC companies. It also uses MEAT criteria in procurement, but the focus is on all parties in the construction supply chain and the collaboration between them. Through common incentive structures, goals and governance the building client can gain a high degree of budget security and make very competent stakeholder management possible, since the transparency level is high. The number of potential mistakes, which will compromise the final quality of the project, can also be reduced. Project partnering requires a mature organisation that can have a deep collaboration with other companies, build and manage trust and create the right environment for bilateral governance.

At the final and fourth step in the model is strategic partnering or strategic partnership. Being a relational procurement type, it shares many similarities with level three, but it has some additional features, which can create value and cope with complexity. To start with it is strategic, which means that the building client needs to have the top management directly involved, or people in the organisation with a lot of decision power, who can speak on behalf of the top management. Many projects are completed using the same team and as such, procedures and operations, can be tailor made to the building client, making reporting and assurance much more simple and transparent. It requires a very mature building client organisation since the collaboration with the AEC consortium/companies becomes very important to the building client, and as such the procurement process becomes a “make or break” moment for the building client, which is not the case for normal procurement. Because of the strategic nature of the strategic partnership it becomes an important commitment for the building client. This also means that the procurement function becomes more important. At the same time, the building client will have to place even more trust in the bilateral governance structure and the common incentive structures ensures that the building client gets the best product possible. This may not be immediately apparent, since this procurement scheme requires a very large upfront investment of the building client and the AEC companies.

The maturity model is a potential performance model, which means that it is not a natural progression from one level to another. A building client may never advance from level one on the maturity model, and depending on the type of construction projects or type of organisation, this may be completely justified. If the type of construction projects are simple and there is a healthy and robust market with many companies able to produce the product or service, there is no need to use advanced procurement measures, which have a bigger overhead and will not

yield a lot of value. On the other hand, if the construction projects are very complicated or completely new to the building client or the entire building industry, more mature procurement schemes will increase budget security and a much better understanding of cost drivers. If the projects have a large and diverse stakeholder group, a more sophisticated procurement strategy will enable the building client and AEC consortium/companies to have a more holistic stakeholder management strategy and in this way give the project a higher chance of succeeding on multiple criteria.

Not all building projects need to be procured using advanced procurement methods, but many would benefit from it, and this requires more mature building client organisations to handle these more mature procurement processes. In the end, the right procurement process is more important to use than the most advanced or the simplest. The procurement method needs to fit both the building client and the project or portfolio.

### 6.3 BUSINESS MODEL ARCHETYPES AND FRICTION

In the third paper, see appendix C, the main goal was to analyse the friction that companies face when changing business models due to value chain reconfiguration in a strategic partnership. The title of the paper is:

*“Reconfiguring the construction value chain: Analysing key sources of friction in the business model archetypes of AEC companies in strategic partnerships”*

To make the friction analysis it was necessary to create four archetypical business models from the construction supply chain. From these archetypes the friction can be identified both internally and between business models. The architect, engineer, contractor and material supplier are described using four categories; value proposition, profit formula, resources and processes. The business model framework used is the Five Block Business Model (FBBM) framework developed by Christensen et al. (2016). A simplified version of the framework can be seen in Figure 14 and the developed archetypes in Table 20.

The identification of these four archetypes can be used in several ways. It can be used in business model analysis and business model innovation. The archetypes create a foundation from which it is possible to make comparisons to other industries and if there are special business model considerations in the construction industry. Each archetypical company has different ways of operating, which shows up in the business model, and as such these can be used to make cross industry business model analysis. For business model innovation, it is possible to see, if a certain proposed business model change will adversely or positively affect the company type that the new business model is proposed for. Understanding, how the company creates value and which profit formula it has, is very important when making changes, since a disruption in the fundamental workings of the company may be very hard or impossible to implement (Kim & Min, 2015).

The archetypes in themselves do not represent the entire business model for a given company. They are commonalities, which are shared by most of the companies of a specific type. Furthermore, business models are not very much used as an analytic framework among practitioners in the construction industry, and the creation of the archetypes can be a starting point for companies to better understand their own company and create their own business models. Researchers, who have worked with business models in construction, have been of the

opinion that the low level of knowledge of business models in the construction industry is a detriment to the industry. The business model archetypes can hopefully be a way to remedy this.

The FBBM framework enables the creation of parsimonious business models, which are simple to develop and communicate to practitioners. In this way business models and business model archetypes can be used to further the understanding of companies in the construction industry.

Table 20 The four archetypical business models of AEC companies and building material supplier (Berg et al., 2021).

	<b>Architect</b>	<b>Engineer</b>	<b>Contractor</b>	<b>Supplier</b>
Value propositions	<ul style="list-style-type: none"> <li>• High architectural quality</li> <li>• Art</li> <li>• Prestige (reputation)</li> <li>• Development</li> <li>• Advise the client</li> <li>• Listen to the users</li> </ul>	<ul style="list-style-type: none"> <li>• Advise the client</li> <li>• Prestige (reputation)</li> <li>• Ensure the building's durability</li> <li>• Innovative solutions</li> <li>• Trustworthy solutions</li> </ul>	<ul style="list-style-type: none"> <li>• Convert project material to buildings -&gt; buildability</li> <li>• Give the client what is economical possible in the project</li> </ul>	<ul style="list-style-type: none"> <li>• Products with few flaws and complaints</li> <li>• Sustainability &amp; Comfort</li> <li>• Materials are delivered on time</li> </ul>
Profit formula	<ul style="list-style-type: none"> <li>• Selling hours to cover high variable costs</li> </ul>	<ul style="list-style-type: none"> <li>• Selling hours to cover high variable costs</li> </ul>	<ul style="list-style-type: none"> <li>• Ensure constant cash flow to cover variable costs and contractual risks</li> </ul>	<ul style="list-style-type: none"> <li>• Sales of products and systems</li> </ul>
Resources	<ul style="list-style-type: none"> <li>• Creative and competent employees</li> <li>• Strong digital tools</li> <li>• Communication resources</li> <li>• Commercial relations</li> <li>• Project management and control</li> </ul>	<ul style="list-style-type: none"> <li>• Strong professional skills especially on technology</li> <li>• Strong digital tools</li> <li>• Commercial relations and project alliances</li> <li>• Project management and control</li> </ul>	<ul style="list-style-type: none"> <li>• Construction skills specially trained employees</li> <li>• Special equipment</li> <li>• Purchasing</li> <li>• Competencies</li> <li>• Project and construction management</li> </ul>	<ul style="list-style-type: none"> <li>• Production facilities</li> <li>• Manufacturing expertise</li> <li>• Good relationship with customers / contractors</li> </ul>
Processes	<ul style="list-style-type: none"> <li>• Integrate aesthetics and function</li> <li>• Set the right teams</li> <li>• Convert ideas / needs into design</li> <li>• Create a basis for construction,</li> <li>• Win competitions</li> <li>• Continuous development</li> </ul>	<ul style="list-style-type: none"> <li>• In-depth technical studies</li> <li>• Keep the balance between unique and standard</li> <li>• Make "good enough" solutions</li> <li>• Quality assurance / review</li> <li>• Secure realizable solutions (buildability, architecture, price)</li> </ul>	<ul style="list-style-type: none"> <li>• Calculate expenses</li> <li>• Read the market (expenses, capacity, etc.)</li> <li>• Adhere to schedule and flexibility</li> <li>• Manage purchasing and logistics</li> </ul>	<ul style="list-style-type: none"> <li>• Understand the market on the short and long term (10, 20, 30 years)</li> <li>• Develop new products / new markets</li> <li>• Optimize production</li> <li>• Advertise products</li> </ul>

The business model archetypes can be used to analyse the construction supply chain, when changes in the procurement or structure of the supply chain is implemented such as strategic partnerships, see Table 21. These changes can be implemented by one part in the value chain, but they can impact another part in a way that is not obvious to the company implementing. This can create friction in the value chain or lead to sub-optimal performance of the entire value chain. It is also very self-evident, why certain types of companies in the value chain tend to merge. The architect and engineering companies have very similar business models and crucially the profit formula is identical. This means that these types of companies can merge without a fundamental change to their business practices and they can get the benefits of a hierarchical governance structure. In recent years there have been several examples of such mergers in the Danish construction industry.

Table 21 Identified points of friction between archetypes and strategic partnership AEC business models (Grey cells are internal friction and white are external friction) from (Berg et al., 2021)

Friction with Archetype	SP Architect	SP Engineer	SP Contractor	SP Supplier
<b>Architect</b>	Value proposition: <ul style="list-style-type: none"> <li>Sufficient focus on aesthetics</li> </ul> Profit formula: <ul style="list-style-type: none"> <li>Replicated solutions</li> </ul> Resources: <ul style="list-style-type: none"> <li>Competences for integrated teams and portfolio management</li> </ul>	Process: <ul style="list-style-type: none"> <li>Engineer has influence on architectural design</li> <li>Dividing project management responsibility</li> </ul>	Process: <ul style="list-style-type: none"> <li>Contractor has influence on architectural design</li> </ul>	Process: <ul style="list-style-type: none"> <li>Supplier may have influence architectural design</li> </ul>
<b>Engineer</b>	Process: <ul style="list-style-type: none"> <li>Architect has an influence on engineering design</li> <li>Dividing project management responsibility</li> </ul>	Resources: <ul style="list-style-type: none"> <li>Competences for integrated teams and portfolio management</li> </ul> Process: <ul style="list-style-type: none"> <li>Using in-house resources effectively</li> </ul>	Process: <ul style="list-style-type: none"> <li>Contractor has influence on engineering design</li> <li>Deliver the right level of documentation</li> </ul>	Process: <ul style="list-style-type: none"> <li>Supplier may have influence on engineering design</li> </ul>
<b>Contractor</b>	Resources: <ul style="list-style-type: none"> <li>Employees for competent early involvement</li> </ul>	Resources: <ul style="list-style-type: none"> <li>Employees for competent early involvement</li> </ul> Process: <ul style="list-style-type: none"> <li>Define the right level of documentation</li> </ul>	Profit formula: <ul style="list-style-type: none"> <li>Consultancy as a revenue stream</li> <li>Open books</li> </ul> Resources: <ul style="list-style-type: none"> <li>Competences for integrated teams, portfolio management and consultancy</li> </ul>	Process: <ul style="list-style-type: none"> <li>Supplier may have influence on choice of materials</li> </ul>
<b>Supplier</b>	Resources: <ul style="list-style-type: none"> <li>Employees for competent early involvement</li> </ul>	Resources: <ul style="list-style-type: none"> <li>Employees for competent early involvement</li> </ul>	Resources: <ul style="list-style-type: none"> <li>Employees for competent early involvement</li> </ul>	Profit formula: <ul style="list-style-type: none"> <li>Consultancy to be included</li> <li>Open books</li> </ul> Resources: <ul style="list-style-type: none"> <li>Competences for integrated teams and portfolio management and consultancy</li> </ul>

## 6.4 TAXONOMY OF RELATIONAL CONTRACTS

The previous sections show the results from the three papers and in this section the results of the scoping literature review are presented. This is done in order to put strategic partnerships into the context of other relational contract types.

In order to make a comparison between the established relational contract types, Partnering, Alliancing and Integrated project Delivery (IPD), the key attributes from Table 4, Table 6 and Table 8 were ordered and condensed. Comparing this ordered and condensed list of key attributes is a similar list of key attributes for strategic partnerships. The key attributes for strategic partnerships are from Gottlieb et al. (2020a) and Berg et al. (2022a).

Table 22 Comparison of key attributes found in partnering, alliancing, IPD and strategic partnership

Key attribute	Partnering	Alliancing	IPD	Strategic partnership
Trust	✓	✓	✓	✓
Aligned goals	✓	✓	✓	✓
Common plan	✓	✓	✓	✓
Common values	✓	✓	✓	✓
Equity	✓	✓	✓	✓
Joint decision making	✓	✓	✓	✓
Common conflict solving	✓	✓	✓	✓
Open information	✓	✓	✓	✓
Open books	✓	✓	✓	✓
Multiparty agreement		✓	✓	✓
Early team creation		✓	✓	✓
Shared risk and reward		✓	✓	✓
Joint responsibility for the design and construction		✓	✓	✓
Collaborative environment		✓	✓	✓
No litigation clause		✓	✓	
Single firm			✓	✓
Cost savings			✓	
Profit-at-risk			✓	
Building information modelling			✓	
Target costs			✓	✓
Joint venture				✓
Conflict escalation system with possibility for litigation				✓
Framework agreement				✓

Across partnering, alliancing, IPD and strategic partnership there are many common features. These similarities have also been found for the first three in previous research (Lahdenperä, 2012). In all four relational contract types there is a focus on communication and collaborative decision making, which is the defining feature of bilateral governance contracts. They have a focus on trust and cooperation that are hallmarks of a relational contract. Another key component is “Open books” cost calculation within the project. The open books mean that all estimation of cost from design work, the construction phase and in some cases operations are open for all project participants. This means that project alterations, risk allocation and

benchmarking of cost to performance can be done knowing the impact for the project as a whole.

That the four types of relational contracts share a specific origin in time and geography can maybe help to explain the many similarities between them. They also share the same theoretical background in that they focus on collaboration, trust and conflict resolution.

From the key attributes of relational contracts found in Table 22 the close relationships between the contract types is clearly evident. It is possible to see these contract types as belonging to a family of relational contracts, who all share core attributes, similar to how organisms who evolved from a previous common ancestor will share traits. Using this analogy from biology it is possible to make a family tree or a taxonomy of relational contracts. Similar research have been undertaken previously, most coherently by Lahdenperä (2012), and to this family tree it is possible to add strategic partnerships, as shown in **Error! Reference source not found..**

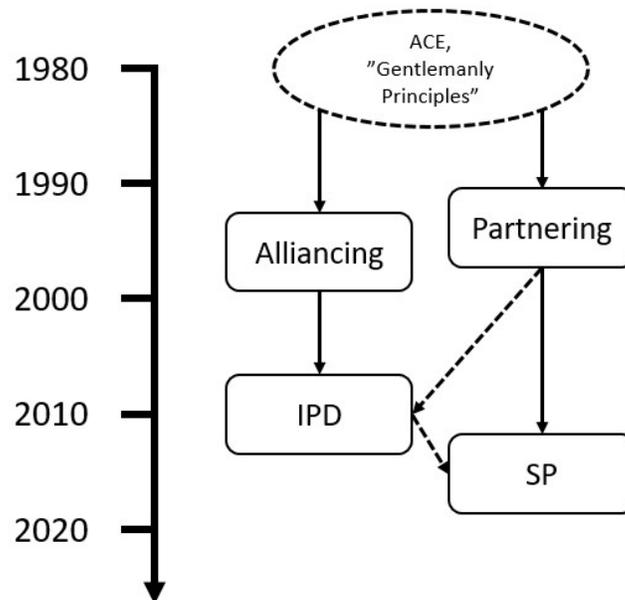


Figure 16 Taxonomy of relational contracts; Partnering, Alliancing, Integrated Project Delivery (IPD) and Strategic Partnerships (SP)

In Figure 16 the taxonomy starts from an early stage of relational contracts. For these contracts, which are mostly based on cultural norms like “Gentlemanly principle” for business interactions in Japan and more formal but non legally binding agreements made by the Army Core of Engineers (ACE), there are some of the key attributes later used (Lahdenperä, 2012; Tvarnø, 2015). The first instance of one of the three main types of relational contracts Partnering is fully formulated by Latham (1994) in the beginning of the 1990s in the UK. This development of Partnering, was concurrent with the work by the oil and gas industry called CRINE, also in the UK, which would later become Alliancing developed in Australia (Hietajärvi & Aaltonen, 2018; Spaven, 1993). The main difference between partnering and alliancing is that alliancing has a stronger emphasis on profit sharing. This may be due to the fact that alliancing was developed by the oil and gas industry and as such all participants have a strong profit motive and the potential for large profits from subsequent production are very large. Partnering on the other



hand was developed by public building clients and they are not profit driven and as such a profit sharing scheme is not as attractive. Furthermore the types of projects that a public building client will typically make are often not profit generating. This means that the collaborative aspect is more driven by soft factors than hard profit motives. Another aspect that separates Partnering and Alliancing is the “no litigation” clause in Alliancing, which prohibits parties from seeking conflict resolution by using the legal system. Partnering does not have this stipulation.

More than a decade later IPD is developed in the US (AIA, 2007). With strong inspiration from alliancing this relational contract type emphasizes even more the creation of a cross company identity and the creation of a cohesive team (Choi et al., 2019). IPD like alliancing has a strong focus on profit sharing and adds a focus on cost savings and building information modeling (Elghaish et al., 2021). How much inspiration the development of IPD has from Partnering is not possible to determine, but there certainty is inspiration taken from Partnering to IPD (Lahdenperä, 2012).

The newest addition to the relational contract taxonomy is strategic partnership (abbreviated SP in **Error! Reference source not found.**) which was first created in 2016 (Frederiksen, Fredslund, & Gottlieb, 2019). Sharing many traits with the three main established forms of relational contracts, its development was inspired from relational contracts in Sweden and UK following Partnering principles. There are however clear inspiration from IPD and the focus on the cohesive cross company team. It can be argued that strategic partnering, a sup-type of partnering, and strategic partnership are indistinguishable since they both concern relational contracts in framework agreement. Strategic partnerships are however very clearly defined with governance structures, framework agreement, joint venture of AEC companies and the conflict escalation system (Berg et al., 2022a). This makes strategic partnership a clear evolution on existing Partnering definitions.

## 7 DISCUSSION

In this PhD research, a number of broad topics have been part of the research such as business models, maturity models and procurement innovation. While these have been used as a starting point for the research effort, each is in its own right a massive field that has not been covered in its entirety in this thesis.

The discussion is presented in four sections:

- Discussion of results
- The framing of the PhD research
- Areas of further research
- The future of strategic partnerships in Denmark.

### 7.1 DISCUSSION OF RESULTS

Sustainability is in a way a backdrop to the entire PhD research work, but not the focus of the research itself. It can be seen as one of the forces driving more building clients to make more complex requirements for buildings necessitating a more elaborate governance structure. Strategic partnerships can support a sustainable value set from a building client, but the building client has to have sustainability and which kind of sustainability as an articulated goal for the strategic partnership. In this way strategic partnerships supports sustainability agendas but they do not drive them, because a strategic partnership does not hold this kind of intrinsic value set. They have to be defined by the building client and then be part of the evaluation criteria when selecting the strategic partner and in the subsequent management of and benchmarking in the strategic partnership.

There are four main results presented in this thesis. It is important to note that these results all come with limitations because of the research method, data gathering strategy and the theoretical framework chosen.

The Danish model for strategic partnerships presented in section 6.1 is primarily build on a longitudinal case study. In a case study of this type detailed description is favoured over general applicability (Eisenhardt, 2007). A result such as this should be viewed in the proper context and cannot be relied upon outside this context. Many factors may influence the generalizability of the result presented. One may be the low power distance found in Denmark, making collaboration across companies and hierarchies simpler compared to high power distance countries (Hofstede, 2011). Contracting and the broader area of company governance has likewise with the help of fellow researchers and literature been narrowed in scope for the research. This was at the cost of covering in depth very important topics like trust, information and negotiation. While these topics are of great importance, the research focused more on the structures surrounding the interactions of companies, and less on the internal workings and day-to-day interactions. Other research is being done in this area. One of the notable efforts in the research on strategic partnerships is found in Gottlieb et al. (2020a). The aim of the research is to investigate what happens when the participants in the strategic partnership have differing institutional logics. The interaction between administrative, market, community and project logic is examined and the strategic partnership is seen as a “trading zone” where participants with differing logics can communicate. From this examination trajectories are found for the strategic partnership where the “trading zone” interaction change over time. The findings are in no way at odds with the findings from the PhD research presented in this thesis and supplement with a

deep examination of the interactions inside of a strategic partnerships. Understanding that even with the same starting point two strategic partnerships can develop in very different ways, supports the research presented in the paper in this thesis on procurement innovation (Berg et al., 2022a). With the development of the Danish model as a type of strategic partnership a diversion from the public procurement framework template developed by REBUS was found in each specific instance of a strategic partnership. These deviations or adaptations were made to suit the local context. Combining the two findings shows that the starting point for a strategic partnership will in all likelihood be slightly different from any other even though a standard template is used, and the subsequent “trading zone” will also develop and can take different trajectories.

In section 6.2 the CSCT maturity model has a particular perspective on maturity development. This perspective is “potential performance” where the maturity level is a conscious choice, and an appropriate level should be part of a deliberate analysis. This perspective ignores the natural tendency of relationships to mature over time which is included in the “lifecycle perspective” (Wendler, 2012). In this way the CSCT model encourages the deliberate and calculated over a natural and organic development in the relationship between building clients and AEC companies.

The business model archetypes developed and presented in section 6.3 are simplistic in nature. They do not show the wide variety of business models in every category and also do not have an exhaustive list of descriptors in each of the four categories. The sacrifice of detail aids in highlighting the differences between business models but also do not show the extend of the similarities between the business models. The very simple framework chosen do not lend it-self to in-depth analysis and as such for a deeper analysis the framework developed by Osterwalder would be more suited (Osterwalder et al., 2010). In business models there are several schools looking at different types of model frameworks, use cases and assessments of what business models are. In using business models, the focus has been on using frameworks, which were deemed suitable for the purpose of the research. This has not diminished the importance of other business model frameworks, but a choice was made based on the available information.

As for the taxonomy presented in section 6.4 this view of the development of relational contract types do not account for the myriad of interactions and sharing of ideas that have been present since they first appeared. As shown by the quote from the Latham report in section 2.2 both the efforts leading to partnering and alliancing were made simultaneously and by people who were aware of the other and saw similarities. While the taxonomy seeks to put defined labels and initiating time on the different relational contract types, the lack of generally accepted definitions introduces an uncertainty.

In general the theoretical frameworks chosen and used in the research presented in this PhD all have common roots in economic theory. The subject of investigation in the research is on an organizational level. This leaves out important nuances which could be gained from using e.g. theory from anthropology. The economic organizational perspective precludes the study of what happens on an individual level and it also assumes that organisations function independent of the individual people in them. This is of course a simplification, which makes the development of tools and procedures much simpler, but at the cost of significant blind spots. Areas such as trust and relationship building are among these areas that are important to get a full picture of relational contracts (Challender, Farrell, & Sherratt, 2015; Kadefors, 2004). An argument for why the organizational level of research is important is that it is through these models and

simplifications that organizations are managed. While it would be preferable for managers of an organization to have a full context picture of how their organization functions, once the organization is sufficiently large it is no longer possible. Here the models and simplifications are useful to guide management and to support researchers seeking to understand these large complex webs of human interaction that are organizations.

## 7.2 FRAMING OF THE PHD RESEARCH

During the development of the research project, the conceptual model of how procurement innovation comes about has changed. The procurement innovation does not happen in a vacuum and has several inputs, one of which is the business models of the companies in the construction industry. The building client has to tailor the procurement scheme to fit with the business models of the companies in the industry and at the same time, the procurement innovation influences the business models. The companies are affected if the building client organization manages to execute the new procurement scheme through changing and maturing their own organisation. In this way the model of connections of the papers and the research can be modelled as see in Figure 12.

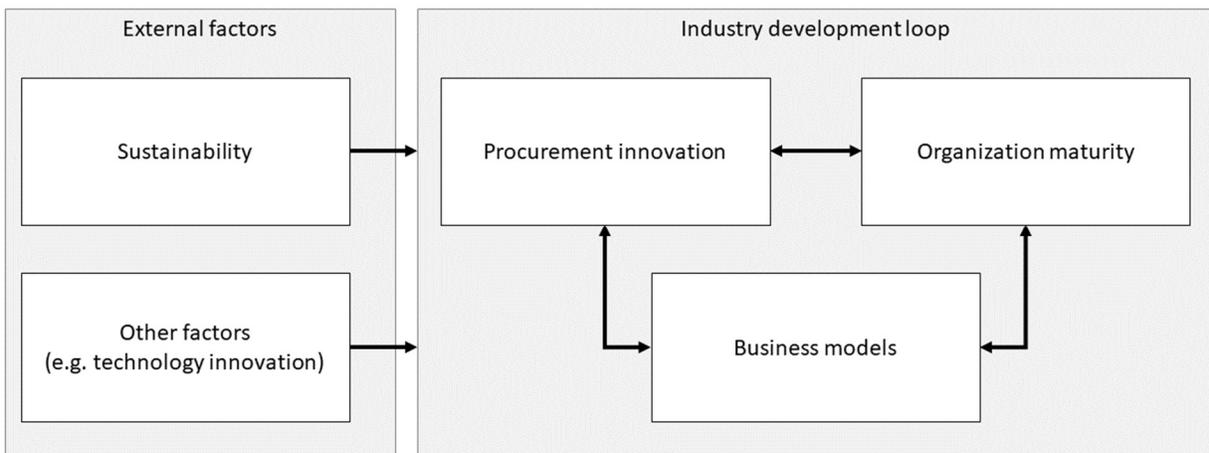


Figure 12 Conceptual model for the connections of the thesis themes in the industry development loop.

With inspiration from other models modelling information flow in project based companies, this model shows how external factors from society, technology or other outside influences first inspires or forces the change in the industry development loop (Gann & Salter, 2000). These external factors will not directly affect the different parts in the industry development loop equally. The sustainability demands may influence the procurement innovation and the business model aspects more, but then indirectly force organizational maturity to cope with the changes in the other two aspects. The organizational maturity may have to increase to cope with a new procurement scheme and this in turn changes the boundary conditions for the companies in the construction industry. The business model of these companies then has to change to fit the new reality. At the same time, these business models from the companies are themselves a force that influences the procurement innovation.

## 7.3 FURTHER RESEARCH

With regard to further research, the field of relational contracting and strategic partnerships is still very young, with lots of room for developing new theory, definitions and consolidate existing views. Further research can be made in refining the terms in relational procurement, and research effort in the Nordic countries is under way. Understanding the different flavours of relational contracts and their strengths, weaknesses and similarities will be very important. In this theses, a small contribution to this effort has been made but there is a lot more to uncover.

Business models and the descriptions of archetypes needs to be further developed in order for researchers to have a clear starting point, when looking at business model innovation and development in the construction industry. Knowing where the companies' present state is, enables a much more realistic analysis with greater explanatory power. Using different business model frameworks and methods of creating the business models, will make for a much more nuanced understanding of where the construction industry is today and where it will be in the future.

The business model archetypes are however only one side of the picture, the company side. On the other side are the building client organisations. While it may be possible to specify a business model archetype for a number of building clients, it has been deemed outside the scope of the research work. Building clients will have a wide variety of business models in terms of what the building represents, how it is to be used and the return on investment, which they expect. This may be an area of further research, which can be undertaken in the future.

In the following sub-sections four areas of further research are identified.

1. The Danish model for strategic partnerships presented in section 6.1 is already evolving and one area is the duration of the framework agreement.
2. The CSCT maturity model, see section 6.2, has a final maturity step which is a framework agreement, but the model does not account for the general effects of using framework agreements. Another area of possible development is the inherent building client perspective in the CSCT maturity model.
3. The further development of models to support procurement method decisions should be made.
4. The business model archetypes presented in section 6.3 are focused on AEC companies but a similar archetype creation could be made for building clients. There is also not a generally accepted business model framework for construction business model research and developing such a framework would help the development of the field.

### 7.3.1 FURTHER RESEARCH ON THE DANISH MODEL FOR STRATEGIC PARTNERSHIPS

In the Danish strategic partnership model, as well as other models that use framework agreements, a duration has been set at four years. This means that in the four years the agreement lasts, new building projects can be initiated and the total length of the strategic partnership is thus four years plus the completion time of the last building project in the partnership, which can extend for several years after. It can be argued, that this is too short a timeframe and that it should be extended, and we do see some cases where the framework

agreement is a 4+1 or 4+2 year setup. This enables the building client to extend the duration of the framework agreement, if it is deemed advantageous.

A perspective in favour of changing strategic partner with an interval of four years is the “capability rigidity” perspective. If we look at the strategic partnership organisation as a whole as the processes matures and the systems are refined, the strategic partnership becomes good at solving a specific range of problems (Ritala, Heiman, & Hurmelinna-Laukkanen, 2016). The organization will after some time of adjustment develop a number of “zero level” capabilities as described by Winter (2003), which enables the day to day operation of the strategic partnership to work. But this does not foster the dynamic capabilities that are necessary to stay relevant in a market with ever-changing demands, materials, processes and technology (Teece et al., 1997). To facilitate this in a building client organization but also for the companies, the automatic contract termination dictated by public procurement law may be a blessing in disguise. Resetting the strategic partnership, re-evaluating the portfolio and in some cases working with a new strategic partner ensures that the ad hoc problem solving capabilities of the organisation are kept and that it can change to meet new challenges in a better way. It is a plan to organizationally improvise described by Miner et al. (2001), which keeps the strategic partnership better prepared for future challenges. This is an interesting area for further research.

### 7.3.2 FURTHER PROCUREMENT MODELS

In the paper presenting the CSCT maturity model (Berg et al., 2022b) several limitations to the maturity model is recognized. One of the greatest is that the model incorporates procurement methods from two fundamentally different regimes; single project and project portfolio. While the CSCT model at level one to three shows procurement schemes that are relevant to single project contracting the fourth and final maturity level is a procurement scheme that is specifically designed to work with portfolios of building or renovation projects in a framework agreement.

There are a number of advantages associated with the switch to a framework agreement, but the ones associated with a framework agreement on its own is excluded from the CSCT model, because a framework agreement is not exclusive to relational procurement strategies. A simple price based strategy will work just fine with a framework agreement and may be most appropriate, if a portfolio of simple building products or services are procured, and it could include parallel framework agreements with different companies with selection for each assignment based on an allocation process. Therefore a simple two by two matrix can be developed as seen in Figure 11, which can be used by a building client to evaluate the use of framework agreements.

The model uses the same classifications and naming conventions developed by Williamson (1979) on the y-axis. These are non-specific and idiosyncratic, where non-specific construction projects are those that are not specifically designed or use materials that are tailor made for the client. Examples of this could be types of warehouse construction or the laying of sewage pipes. Idiosyncratic construction projects are projects where the design and the final building is bespoke to the individual client and project. On the x-axis the discriminating factor is if the project is a single project with a one off transaction or if there are multiple projects in a project portfolio.

Investigating the types of models needed to evaluate optimal procurement strategies is not a part of this PhD, but it may be an area for further research.

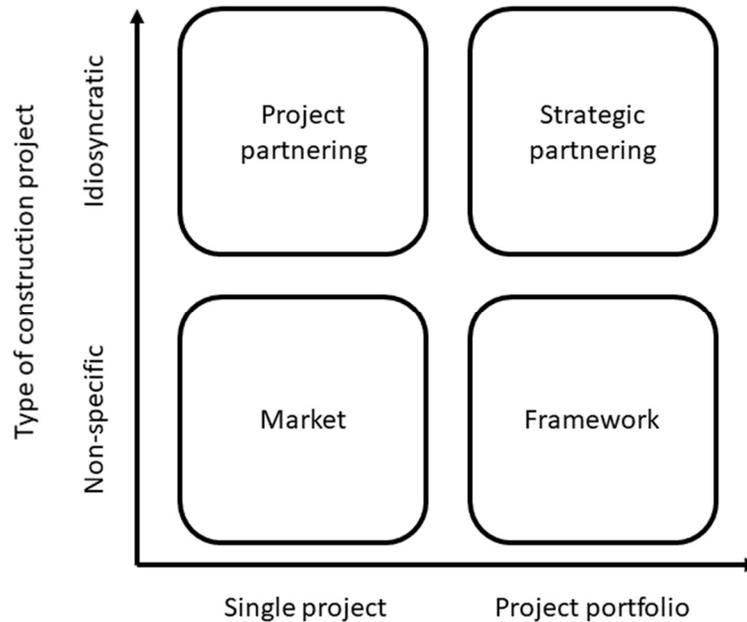


Figure 11 A two by two matrix to evaluate the use of framework agreements and strategic partnering

Another possible development of the CSCT maturity model is associated with a building client perspective and not the AEC companies' perspective. This building client perspective can be seen in the "Cost transparency" criteria being in the "Value" dimension. For supplier companies this would not necessarily be seen in the same way, since price and cost information for a company may be regarded as key confidential information. Giving the building client and/or other companies in the construction value chain access to the internal calculations and actual cost structure would in many cases be a very difficult task requiring a lot of trust. It would therefore not be in the value dimension but in the complexity dimension if the same evaluation was done for a company in the construction value chain. While the CSCT model can be used by any company buying building services, including companies in the construction value chain, it cannot be used to evaluate whether to enter into such an agreement. Making a maturity model that took the vantage point of a company being hired would be an area of further research.

### 7.3.3 MODELS TO SUPPORT CONSTRUCTION PROCUREMENT

At the core of TCE is the idea that there is not a one size fits all approach to transactions (Williamson, 1979). If there was such a "best in all situations" transaction type there would be no need to make the individual analysis and assessment that TCE advocates. The construction industry is however in a bit of a special predicament, especially when it comes to public procurement of building services. For decades, especially in the European Union, the notion of transparency in public spending and procurement has been front and centre (European Commission, 2015). Within a lot of categories of goods this is a perfectly valid strategy, both from a TCE and a spending transparency perspective. However when it comes to the procurement of complex systems, like bespoke IT software or a building project, from a TCE perspective a simple price competition is exactly the wrong strategy (Loosemore & Richard, 2015). Since the number of unknown external factors, need for project specific investment and outcome uncertainty is all high, making the judgement of who to award a contract based on a single parameter is a very risky strategy. The risk is most often shown in a large number of cost

overruns, project delays and quality issues. Add to this the risk of predatory behaviour on the part of the tendering companies who may see litigation as a more profitable business strategy compared to actually delivering the project.

It is an interesting observation, and one Williamson made himself in the 1970's, that market strategies are as prevalent as they are.

*“The question of why there is so much vertical integration remains interesting, but no more so than the question of why there are so many market- (and quasi-market) mediated transactions” (Williamson, 1979)*

This is especially the case in construction where market mediated transactions should in any reasonable scenario be a very small percentage of all building procurement. The continued use of price based market contracts serve a number of functions, but delivering the best building project is not one of them (Loosemore & Richard, 2015). The EU has been promoting a harmonization across countries and has a strong focus on transparency and objectivity in public procurement (Bovis, 2007). When a building project is initiated, it is done so within a regulatory framework which has both national and international components (Lillie & Greer, 2007). Modern frameworks and regulations regarding buildings can be very extensive and encompasses as diverse aspects as zoning laws, municipal plans and regulation of public procurement (Thorson, 1997, Sourani & Sohail, 2011). The latter has particularly impacted the way public building clients engage in construction projects (Burke & King, 2015). Using the transparency and objectivity principles the EU has devised six generally applicable procurement procedures of which three support relational contracts; Competitive negotiated procedure, Competitive dialogue and Innovation partnership (Chong et al., 2013).

The maturity model developed as part of the PhD research is a model that seeks to support public and private organisations and companies to make better building service procurement decisions. This work should be continued to enable more procurement schemes to be evaluated and academics should engage in the theoretical development of procurement based on e.g. TCE. The future tends towards more complex products meeting more complex demands and as such more sophisticated procurement schemes are needed in order to effectively cope with the complexity. The construction industry has a unique position in that the product, buildings or renovations already are complex and as such construction will be one of the first sectors that would benefit from sophisticated procurement schemes. Other industries may in the future look to construction in order to get inspiration for contracting and governance when delivering complex goods or services. As such construction management and models supporting construction procurement should be an area of focus for academics and practitioners alike.

#### 7.3.4 FURTHER RESEARCH ON BUSINESS MODEL ARCHETYPES

In the development of the archetypes there have been a clear simplification of the construction value chain. One area that the archetypes do not address is the archetypical business model of building clients. Since building clients from property developers to government institutions have very different organisational structures and very different value logic this was deemed outside the scope of this scientific investigation. It is however interesting to investigate how these business models of building clients influence the rest of the supply chain, especially with regard to changes in the governance of projects like strategic partnerships.



Another area that should be investigated is the role and use of different business model frameworks in construction research. While business models are a very useful tool depending on which framework have been used to make them they will be useful for different purposes. Frameworks that use a large number of dimensions like the Business Model Canvas (BMC) can be useful to make detailed analysis and find differences between companies in the same place in the construction value chain. However when analysis is done across the value chain this amount of detail can be counterproductive. The many dimensions can also make it hard to have feedback from practitioners since the complexity requires a lot of prior experience with business models. There is also a tendency to use bespoke business model frameworks in construction business model research. This makes comparison of different studies hard to compare since dimensions do not line up and the bespoke framework is very narrow in its description of attributes of the companies. A more thorough analysis of appropriate frameworks for construction business model research, evaluating frameworks strengths and weaknesses, would be helpful to the research community.

As a research field business models is still young compared to other management and economic research topics (Wirtz et al., 2016). This shows in a number of ways, the most important being the lack of standard frameworks and general standards for business models in construction. While method and approach diversity has merits and often contribute to a rich and varied research field, too much makes it hard for the field to develop. Based on the current literature the propensity to develop bespoke business model frameworks in construction business model research is a classic case of much diversity and little development.

While the topic that prompted the research into business models in this PhD project was to understand what happens to companies that participate in strategic partnerships, one of the main contribution to the academic development of construction business model research is the development of the business model archetypes. While understanding the friction that happens between and inside companies that participate in strategic partnerships is an important perspective, the archetypes enable a much wider scope for developing and testing new theory in construction value chain management. The archetypes enable analysis where a new configuration of the value chain or the introduction of a new technology can be analysed in terms of how it changes the business models of companies in the construction value chain. This analysis can then be part of the evaluation of whether the intervention is feasible or desirable when taking into account the challenges it represents in terms of reconfiguring the business models of the companies.

There is also a need to identify business model frameworks that work for the construction industry and what these frameworks are suited for. The popularity of BMC in general and being one of the few business model framework that has been use in construction business model research, shows that it has great qualities. BMC is a great reductionist tool, breaking down the value creating logic of a company and using nine dimensions of analysis. This makes it less suited to the kind of cross value chain research that has been the focus in this PhD. Sacrificing some of the granularity and small scale detail, cross value chain research should aim for business model frameworks that can describe a heterogeneous collection of companies. The ability to evaluate change across business models in the construction value chain is both a function of having a starting point and a framework to record change. The FBBM framework developed by Christensen et al. (2016) and the business model archetypes are two such tools

that can be used for this type of analysis and the number of cross value chain phenomena that can be analysed is vast.

#### 7.4 THE FUTURE OF STRATEGIC PARTNERSHIPS IN DENMARK

In the last six years strategic partnerships have seen significant growth in Denmark as measured by tendered frameworks contracts, see Figure 17. In 2021 there was 600 million EUR in turnover per year, which is 1.4% of the total turnover of the Danish construction industry (DST, 2022). Strategic partnerships have shown double digit growth rates in turnover each year and from 2020 to 2021 the annual growth rate is expected to be 27%. The data comes from public tender databases and is estimated by dividing the total tender sum by the duration of the strategic partnership.

The market have been dominated by large portfolios, most being above 100 million euro, but there are only a small number of building clients who can create these. The vast majority of building clients in Denmark are small or medium in size, and we have yet to see how strategic partnerships will work for this type of building client. One example of a medium sized building client is Egedal municipality with a building portfolio tendered in a strategic partnership of approximately 50 million EUR in 2020 (EK, 2020). There have yet to published research or reports evaluating this size of strategic partnership in Denmark. Maybe it is possible for small and medium sized building clients to tender strategic partnerships on their own or maybe they will need to collaborate with others in order to have sufficient volume in the portfolio to support a strategic partnership.



Figure 17 Turnover in strategic partnerships in Denmark estimated from public tender documents

While it remains to be seen if this strong growth in strategic partnerships in Denmark will continue into the future, the development is very interesting both for practitioners and academics alike.

## 8 CONCLUSION

There is a rapid change occurring in the Danish construction industry. New modes of governance are replacing old and familiar ones and this change means a new way of conducting business. Building clients need to incorporate new capabilities to assess strategic partners, need to be able to evaluate progress, jointly administrate building portfolios and benchmark quality and costs of renovation projects. A building client needs to not only clearly formulate goals and values and efficiently communicate these, but also be able to analyse their own organizations and create robust internal assurance. On the other side of the table, companies, who wish to establish long-term mutually beneficial relationships, need to abandon long entrenched business models and develop new strategies to maximize the potential in these new collaborations. Internal benchmarks, employee training and communication strategies needs to be re-examined to be in sync with the new governance modes.

Strategic partnerships is a procurement strategy in the relational contract family. Together with Partnering, Alliancing and IPD it shares many key attributes of the family such as trust, goal alignment and joint decision making. The taxonomy of relational contracts in section 6.4 created based on literature view, shows the development and connections between the three established relational contract types and strategic partnerships. While these contracts share common traits there are also central differences, which makes them suitable for different situations. While strategic partnerships are the latest edition to the family tree of relational contracts it will probably not be the last, and using relational contracts are by no means a panacea for the construction industry.

Using relational contracts like strategic partnerships is a challenge for building clients as well as the entire construction value chain. Creating the necessary maturity in the organizations to execute successful strategic partnerships is a management challenge, which require the involvement of the entire management structure. From the people on the ground working in close physical proximity with new colleagues with an entirely different background and skill set, to the top management, who need to evaluate not on a short-term project-by-project basis but on a strategic long-term level, which requires a deliberate and concerted effort.

As has been found in the numerous interviews, workshops, questionnaires, case studies and literature that has created the foundation for this thesis, the pitfalls are many and varied. From benchmarks, pricing, culture, communication to the seemingly simple task of understanding what a strategic partnership is. One thing is certain, strategic partnerships are not business as usual.

### 8.1 ANSWERS TO RESEARCH QUESTIONS

The research has been driven by the main research question:

*“How do actors in the construction value chain react to the relational contracting practice of strategic partnerships in terms of procurement strategy, organizational maturity and their business models?”*

This main research question is answered through the three academic articles, with three sub-research questions, that are part of this PhD thesis. The first being:

*“How is a procurement innovation supporting sustainable building renovation, in the form of strategic partnerships, defined and replicated?”*

The answer to this can be summarized with the findings from the paper on procurement innovation (Berg et al., 2022a). Strategic partnerships have from the 1990'ies been developed in the UK and Sweden. They have taken several forms and in the UK have been supported by formal contracts. The paper describes the development of strategic partnerships in the Danish construction industry. Here the process of creating a bespoke contract and developing it to a publically accessible procurement framework is detailed. The three development stages of initial experiment, definition and replication are described in a longitudinal case study. The examples of building clients using strategic partnerships together with a proven model for procurement helped to establish what in the paper is described as the Danish model of strategic partnerships.

The second article is on supply chain relationships (Berg et al., 2022b) and answers the following questions:

*“How can a maturity model of procurement relationships in construction be created, in such a way that it takes into account both the positive and negative attributes of using mature procurement relationships such as strategic partnerships?”*

In the literature search a maturity model focusing on procurement relationships was identified in a paper by Meng et al., (2011) called the Supply Chain Relationship (SCR) maturity model. Using this model was however limited to a UK context, had a lifecycle perspective incompatible with procurement and did not take into account the complexity of mature procurement methods. In the paper itself several areas of further research was pointed out and this was the starting point for the development of a new model. The new model called the Construction Supply Chain Transaction (CSCT) maturity model uses the same four levels of maturity as SCR (price, quality, project partnering and strategic partnering) but places them in a Cartesian coordinate system with two dimensions of analysis; value and complexity. The CSCT maturity model has a potential performance perspective and an analysis matrix with seven value and seven complexity criteria enabling a building client to evaluate the potential value and complexities associated with each procurement method. This enables the organisation to evaluate if they have a portfolio and the capabilities in the organisation to execute a strategic partnership.

The third and final article on friction analysis using construction business model archetypes when reconfiguring the construction value chain in strategic partnerships (Berg et al., 2021) answers the question:

*“What are the points of friction in and between business model archetypes when they are subject to transformation in the value chain in the form of strategic partnerships?”*

In the paper, four archetypes of business models in construction are identified and creates a starting point for the analysis of change and potential friction that arises when the companies enter into strategic partnerships. As has been pointed out by other researchers, business models are not detached from other companies in the supply chain, and when a Joint Venture is created by the companies to participate in a strategic partnership, this business model interdependency becomes stronger. In the following are a few of the points of frictions, which can be identified with respect to participating in a strategic collaboration.

Strategic partnerships means that a long-term collaboration, with a high initial investment in infrastructure and governance systems, has to be evaluated over a longer period of time to show its viability as a business activity. The companies cannot expect a high return on

investment in the short run and participation can create friction in and between their business models

Specifically for the architectural business model, the insistence on high architectural quality, prestige and art, has to be valued against the engineers desire for trustworthy solutions and contractors insistence on buildability. For an engineering company, which has expertise in project management, the strategic partnership poses a unique challenge. Both the architects and the contractor will possibly have the same expertise and how this particular task should be divided among the companies is not necessarily straight forward. A source of friction for the contractor is that part of the staff will mainly be focused on consulting. In this way, their salary is covered by the strategic partnership, but since the profit formula for a contractor is based on cash flow this covering of salary is a very low cash flow business compared to signing contracts and delivering building projects. Finally, the material producers are in a very different position compared to the other companies in the value chain. Since they have very big fixed investments in production capacity, they are relying on selling products to cover these large costs.

## 8.2 CONTRIBUTION

The contributions made by the PhD research presented in this thesis follows from the gaps identified in the literature reviews presented in chapter 2. The literature reviews identified the need for research in four areas:

- The similarities and connections between the major relational contracting types and strategic partnerships.
- The development of a relational procurement strategy and a detailed description of how the particulars of a strategy is created.
- Further development of the SCR maturity model with improvements to both the graphical representation of the maturity steps and the KA matrix.
- Business model analysis using parsimonious models from the construction industry with a cross value chain perspective.

In the following sections both the practical and theoretical contributions within in the three identified gaps are presented.

### 8.2.1 PRACTICAL CONTRIBUTION

The three main contributions can be found in the three central papers submitted as part of this PhD thesis. All of the models have their outset in a need that was identified together with practitioners. From the very first workshops and interviews, discussions on what strategic partnerships mean have been common. The identification of the Danish model of strategic partnership, see section 6.1, is a contribution to this discussion by showing one concrete example.

In the same workshops there were also discussions on which capabilities are relevant for strategic partnerships and how they will provide value. The maturity model showing not only the value but also the complexities associated with different procurement schemes, among them strategic partnerships, is a contribution to this discussion. Subsequent research and analysis found these tools to fit with this identified need. The core principles are that of parsimony, making the least complicated model possible, to ensure that it is industry relevant and applicable in a practical context.

## **Taxonomy of relational contracts**

When discussing strategic partnerships in workshops and interviews with practitioners it was often pointed out that a specific part was just like another relational contract type. There was also a lot of questions of which relation contract type was the best. The taxonomy of relational contracts is an answer to some of this type of question. The reason why relational contract types the surface it can be hard to distinguish is because they are related and in a family which shares key attributes. They also differ on many of the same key points compared to traditional market contracts. This does however not make them interchangeable and some relational contract types are better at one thing while another relational contract type is better at another.

The taxonomy should help any practitioner who is looking into relational contracts to understand the family tree of relational contracts, and be a starting point for further understanding of this type of contract.

## **The Danish model of strategic partnerships**

Strategic partnerships are used across industries and in many different contexts and can mean a great number of things. The question was then asked, "What does it mean in a construction procurement context?" This question has been answered by describing a procurement practice that have been named "The Danish model of strategic partnerships" in this thesis.

After the definition of the Danish model was finished it was presented to practitioners at workshops and meetings. The immediate feedback was that the description of "what a strategic partnership is" was useful, but some participants took issue with naming it "The Danish model". To them it implied that it was the only relational procurement practice in Denmark and that maybe a name more tied to either Copenhagen Municipality who first created it or maybe to REBUS who supported the definition of the public procurement framework was more appropriate. It may be given such a name in time by practitioners.

As can be seen in Figure 17 strategic partnerships are becoming a popular procurement practice in Denmark. The development of a defined and reproducible procurement practice have hopefully been part the adoption of strategic partnerships in the Danish construction industry. A number of practical guidelines and a website based on the results of the PhD research is also helping building clients and companies understand this new way of procuring.

## **Maturity model for procurement**

The CSCT maturity model, see section 6.2, was developed with practitioners in mind. While the model has a solid theoretical foundation in maturity models and TCE, the goal of a parsimonious evaluation framework for procurement is purely a practical one. In a purely academic model the cost for including more and in some cases superfluous dimensions is small. In a practical context it is key that a framework is efficient and that the implementation does not require a massive up-front investment when the return on that investment is perhaps small or not simple to discern. The change of procurement practice can be very difficult and the analysis tool that supports this decision should if at all possible not add to the difficulties.

In a practical setting a company procuring building services should use the CSCT maturity model in evaluating the strategic development of the company. The model could be part of a strategy seminar where the different parts of the procurement staff and management are together. The current state of procurement could be discussed from the perspective of the

seven value and seven complexity dimensions of the CSCT model. From this formulating plans to improve on complexity dimensions and evaluate the positive benefits from improving procurement method using the value dimensions.

Communicating that procurement is not a one size fits all and that there are alternatives is a very important first step in introducing new procurement methods. Changing to a new procurement scheme is also not trivial and requires planning and commitment in order for it to become a sustained change and have a high chance of success. The CSCT maturity model can help building clients and companies procuring building services evaluate which procurement scheme is right for them.

### **Business model archetypes**

Business models have for the past two decades been used to analyse and improve countless companies and in the construction industry new approaches to the traditional are being tried. However many practitioners in the construction industry are not very familiar with business models. The business model archetypes, see section 6.3, are for the practitioners who wish to develop new business modes but also for the ones who want to look broader at the construction industry and understand each part of the value chain.

Developing new business models can take many forms and in many cases it is only after they have been implemented is it possible to find out which business model change has enabled a company to have success. However when there is a good understanding of the traditional business model within a segment or part of the value chain it becomes much more simple to identify areas where product, process or another part of the value creating logic can be improved. If a new business model is being introduced into an existing company it is also important to identify internal conflicts in order for the existing and the new business model to co-exist without creating too much friction. It may be very tempting to look at new markets or a new value proposition without considering the potential ramifications. The business model archetypes gives practitioners a starting point in their process to create innovation in the construction value chain.

The archetypes also enable practitioners to look at their own value chain with a new perspective. Implementing new collaboration or development efforts require that there is a clear understanding of all companies' motivation. Both the company the practitioner is representing and all the others in the value chain and they are very different, as is evident from the archetypes. This understanding can enable the project managers to set appropriate goals and expectations, so that all companies are aligned. They do most likely not want the same thing from a given project but the motivation of each company needs to be factored in to the project in order for it to become a success for all participants.

### **8.2.2 THEORETICAL CONTRIBUTIONS**

To make the research anchored in theory and contribute to an academic field, the needs of practitioners was related to active research fields within construction management.

### **Taxonomy of relational contracts**

The development of the taxonomy is a contribution of the growing body of research evaluating and characterizing relational contracts (Anvuur & Kumaraswamy, 2007; Bygballe et al., 2010; Chan et al., 2009; Engebø et al., 2020; Lahdenperä, 2012; Tvarnø, 2015; Y. Zhang et al., 2020).

It shows how the main types of relational contracting, Partnering, Alliancing, IPD are connected to the new type of relational contracting, strategic partnerships. In developing the taxonomy key attributes are identified for each relational contract type. This may help in developing a more generally recognized definition of the different types of relational contracts.

### **Defining a relational contract**

Defining the Danish model of strategic partnerships is part of a continuous development of procurement schemes that support the construction industry (Latham, 1994, Egan, 1998, Wong et al., 1999, Colledge, 2005, Sakal, 2005, Gadde & Dubois, 2010, Kadefors et al., 2013, Plantinga & Dorée, 2016, van Zoest et al., 2019). Public procurement is a broad topic and is a special case of transactions following a number of national, and in the case of countries in the EU, European rules (Haugbølle et al., 2013). To comply with these rules and at the same time make governance structures that can efficiently and effectively handle the processes in the construction industry requires procurement schemes that are tailored to the task.

In describing the internal structure of the procurement agreement and analysing the different parts the definition of the Danish model can serve as an example of how such documents should be described and compared. Such procurement document analysis have been done by Tvarnø (2015) on the similar topic of partnering. Using interviews and workshops to get a deep qualitative understanding of the intentions and real environment of the contract, the description becomes more nuanced compared to a description only using the legal documents. The document only methodology has been used in prior research on the topic of comparing procurement documents and this work could be strengthened by also using qualitative data from practitioners.

Another part of describing the Danish model is the focus on how the contract came to be and not just what it is. Following the procurement scheme from first experiment, through an open development process of public tender document to the replication of the procurement method by other building clients shows how this procurement innovation can be lifted from one-off experiment into an established practice. This is a significant contribution in the research field of construction procurement which is either outcome focused (Osipova & Eriksson, 2011, Witt & Liias, 2011, Carbonara & Pellegrino, 2020) or implementation focused (Bao et al., 2019, van Zoest et al., 2019, Lindblad & Karrbom Gustavsson, 2020). This field of study of creating real change in procurement should have more focus so that new and innovative ideas in procurement are translated into real change in the industry.

### **Maturity model for the AEC industry**

The CSCT maturity model is created to evaluate different types of procurement practices and when each type should be used. As such it is the most recent in a long line of such models (Williamson, 1979, Cox & Thompson, 1997, Eriksson, 2010, Meng et al., 2011). The CSCT model is based on established research and a similar model has not been developed in a construction procurement context. When building a maturity model the progression logic from one level to the next needs to be evaluated as it is dependent on the characteristics of the phenomenon the maturity model describes. In procurement relationships looking on one contract the level of maturity is determined by the signed contract, and in this way it cannot become more mature over time. This then means that it falls in the potential performance category of maturity models, where a maturity level only is increased if it shows a potential



performance benefit to do so. This model is the first to incorporate a potential performance perspective in a construction procurement maturity model.

Procurement relationships are of great importance and within management and economic theory there has been proposed a very large number of different models and paradigms. The CSCT model is based both on the theoretical basis of maturity models and supports TCE analysis of a transaction relationship. This is done within the procurement reality of construction where the relationship types are predefined by contract types and legislation which sets the boundary conditions for transactions in the construction industry.

### **Friction when AEC business models change**

Business models have been used extensively to analyse AEC companies (Mokhlesian & Holmén, 2012, Brege et al., 2014, Zhao et al., 2016, Ling & Li, 2016, Dunphy et al., 2016, Bos-De Vos et al., 2016, Romero et al., 2016, Jonsson et al., 2017, Laine et al., 2017, Zhao et al., 2017, Hart et al., 2019, Jang et al., 2019, Jang et al., 2019). However in all this research the fundamental question of how the business models of the typical AEC companies are have not been answered. While the research in this PhD has centred on strategic partnerships to understand how the companies are changed or challenged by this new procurement practice it is important to establish this starting point.

The business model archetypes developed create the foundation for a new language to talk about change in the construction industry value chain. Whenever there is a proposed new technology or collaboration paradigm it is important to look at the feasibility of implementing this change. Research of the business model implications of the implementation of industry 4.0 and a full digital twin of the value chain, as an example, there is a need to understand the business model of the typical AEC company. In industry 4.0 where high levels of transparency is the goal there needs to be focus on how this will impact the existing business of construction.

To accompany the business model archetypes a useful tool for analysis is the economic term “friction”. Friction in economics predates TCE and TCE describes a specific form of friction in transaction (Aristotle [350 BCE] B. Jowett, 1999, Williamson, 1989, Hardt, 2009). Used together with business models friction explains why a seemingly optimal value logic is not automatically adopted (Kim & Min, 2015).

The business model archetypes and the inclusion of the economic term friction creates a language where researchers can expand the understanding of the construction value chain and the transformation of construction. It seeks to identify the resistance of the value chain to change and how to address and overcome this friction. Instead of blindly developing new processes or copy other industries there should be a deliberate development process where new forms of collaboration and technical tools can be part of supporting the existing value chain and at the same time show how new business models gradually or in special circumstances can usurp existing business models. In this way there is the possibility to make an effort to meaningful change of the construction industry for the better with a higher probability of success.

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# APPENDIX A

Paper - Berg et al. 2022a

*Procurement innovation as a vehicle for sustainable change – a case study of the Danish model of strategic partnerships*

Preprint of the paper

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## **Procurement innovation as a vehicle for sustainable change – a case study of the Danish model of strategic partnerships**

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## **Procurement innovation as a vehicle for sustainable change – a case study of the Danish model of strategic partnerships**

**Purpose:** Efficient and effective knowledge transfer is important in complex building renovation projects. The addition of sustainability requirements in building renovation adds complexity. This paper investigates the development of innovative public procurement schemes to support sustainable building renovation projects. These blueprints for procurement innovation can support similar efforts in other countries.

**Design/methodology/approach:** The research is based on a longitudinal case study using interviews with primary stakeholders and workshops with industry practitioners to supplement the analysis of public tender documents from the Danish public building clients.

**Findings:** The key tenants of the Danish model for strategic partnerships are a single strategic partner, systematic conflict resolution, framework agreements, risk management, and joint educational programs. Three phases in the development of the procurement scheme are identified; experiment, definition and replication.

**Originality:** Strategic partnerships and other types of relational contract schemes are not very prevalent in most countries. How these contracts are developed and defined is not well understood. This paper shows how one such contracting scheme is developed, how it is defined and replicated.

Keywords: sustainable renovation; strategic partnership; procurement; innovation; construction

## **Introduction**

As the complexity of technology and sophistication of building practices progresses the management of knowledge and information across the construction value chain becomes more important (Adafin et al., 2022; Saini, Arif, & Kulonda, 2019; Sergeeva & Duryan, 2021; Vaz-Serra & Edwards, 2020). The main challenge hindering the transfer of knowledge is the traditional fragmented organization and work structure in construction (Saini et al., 2019; Vaz-Serra & Edwards, 2021). Central to changing the organization in construction is procurement practices, prompting the development of relational contracts supporting knowledge transfer such as partnering (Bellini et al., 2016; Lenderink et al., 2020) Traditional procurement is, however, for many reasons, still the prevailing paradigm (NBS, 2018; Mehany et al., 2018; Papajohn et al., 2020). Dissatisfaction with the traditional procurement approach has meant that the construction industry, supported by government actors in several countries, has sought to develop alternatives (Laan et al., 2011; Carbonara & Pellegrino, 2020; Park & Kwak, 2017). This paper presents a case study of such an effort undertaken by actors in the Danish construction industry and public building client organizations, to develop a relational procurement strategy; strategic partnerships. The efforts to create strategic partnerships in Denmark is the latest continuation of more than three decades of development of relational contracts and procurement strategies (Latham, 1994; Egan, 1998; Wong *et al.*, 1999; Sakal, 2005; Gadde & Dubois, 2010; Kadefors et al., 2013; Plantinga & Dorée, 2016).

Change of procurement practices can have a profound effect on the ability to effectively utilize new tools and reach the intended sustainable goals of a building renovation project (Voordijk et al., 2000, De Haan et al., 2002, Uyarra et al., 2014, Häkkinen & Belloni, 2011, Naoum, 2016). The change to sustainable procurement

practices is however fraught with obstacles and finding suitable alternatives to existing products or services is a difficult task (Ryghaug & Sørensen, 2009; Mosgaard et al., 2013; Kadefors et al., 2020).

In modern government procurement practices, there is a great focus on transparency and minimizing accusations of corruption. This has led to procurement schemes where the lowest price bid tenders have become the norm (Wong et al., 1999, European Commission, 2015). By using lowest price as a procurement strategy the transparency is very high, but the price and total cost of construction are not necessarily the same, and this lowest price tender can lead to predatory practices from the bidders (Loosemore & Richard, 2015). Many tendering schemes have been developed, but the lowest price tender is still very prevalent in public procurement (European Commission, 2017).

To solve the perceived problems of price to quality, suboptimal tendering process, and timely delivery, public organizations in several countries have turned to relational contracts in general and strategic partnerships in particular (Kadefors et al., 2013, Lam & Gale, 2015).

Previous research related to construction procurement has focused on the outcomes of implementing a specific procurement practice (Osipova & Eriksson, 2011; Witt & Liias, 2011; Carbonara & Pellegrino, 2020). Some research has been carried out with a focus on the implementation of new and innovative procurement practices (Bao et al., 2019; van Zoest et al., 2019; Lindblad & Karrbom Gustavsson, 2020). There is however a distinct lack of literature describing the development of procurement innovation in construction and in particular about relational contracts.

### ***Research question***

To fill this research gap, the following research question has been formulated:

*“How is a procurement innovation supporting sustainable building renovation, in the form of strategic partnerships, defined and replicated?”*

To answer the research question a longitudinal case study was conducted in the Danish construction industry. Through comparative text analysis of primary sources, the specific details of the new procurement strategy are analysed with respect to the subsequent use of the procurement strategy. To get a more nuanced picture of the development process and how strategic partnerships are viewed by the stakeholders in the construction value chain a number of interviews and workshops are used. The goal is to show how procurement innovation with industry participation can be made to support sustainable building renovation.

### **Theoretical Background**

#### ***Sustainable change***

Since the 1980s, first with the Brundtland (1988) report and later with the United Nations (2015) sustainable development goals and the IPCC (2021) report, the international community has repeatedly put sustainability at the top of the international agenda.

Sustainability has become an important driver in many industries, including the construction industry (Rodriguez-Melo & Mansouri, 2011). One of the ways this can be seen in construction is the development and use of certifications schemes like DGNB and BREEAM that provide a framework to tackle sustainability challenges within the domains of economic, social and environmental sustainability (Haugbølle et al., 2013, Jensen et al., 2018). An area with high potential for impact is the focus on sustainable



building renovation (Jensen et al., 2018; Serrano-Jiménez et al., 2018). Sustainable renovation of buildings entails the use of less raw material, reuse of existing material, augmentation of use and function of existing buildings and inclusion of the local community and architecture (Kamari, Jensen, Corrao, & Kirkegaard, 2019). Creating a sustainable construction industry is highlighting some of the challenges that the industry has. A fragmented supply chain, project-based collaboration and low digitalization are all factors (Vaz-Serra & Edwards, 2021). One of the answers proposed to overcome these challenges is to rethink procurement in the construction industry. (Elhag, Eapen, & Ballal, 2020; Suprpto, Bakker, & Mooi, 2015)

### ***Procurement innovation***

The literature on procurement innovation is large and spans both the public and private sector (Kundu, James, & Rigby, 2020). One of the key challenges in procurement innovation is how to make procurement innovations repeatable (Plantinga et al., 2020). The case study presented in this paper is a description of such a repeatable procurement innovation.

Innovation within procurement does however have challenges and a key obstacle for this is the perceived rigid regulation of procurement (Uyarra et al., 2014). Particularly for the public sector, procurement is strongly regulated to secure open and fair competition, for instance by EU regulations and national legislation (European Commission, 2015). This favours simple contract allocation criteria and this, in turn, creates challenges when developing frameworks for innovative procurements like relational contracting (Jensen et al., 2017; Loosemore & Richard, 2015).

Procurement innovations within relational contracts can be one of the keys to making the construction industry overcome its challenges and become sustainable (Jensen et al., 2018).

### ***Relational contracts***

Relational contracts are suited to long-term projects or collaborations, producing idiosyncratic products or services which are very complicated or complex (Doornik, 2006, Sakal, 2005). A key tenant of a relational contract is that the focus of the contract is on the company or conglomerate of companies delivering the product or service, and not on the product or service itself (Rahman & Kumaraswamy, 2008). A client organization is thus buying the team which best suits the client organization and its goals, and from this starting point, the client organization develops the concrete details of the project in collaboration with the company or conglomerate (Levitt et al., 2012).

Relational contracts are governed through cross-company relationships between people. It is through this interaction that the quality and goals of a given product or service are negotiated (Macnil, 1974). Establishing these personal relationships takes time and as such relational contracts are only applicable in cases where there is a time dimension to the transaction and not for one-off discrete transactions (Johnson, McMillan, & Woodruff, 2002). In recent years there has been a shift towards more strategic and long term commitments between companies such as strategic partnerships (Mouzas & Blois, 2015).

### ***Strategic partnerships***

As a relational contract type “Strategic partnerships” have their origin in the 1990s. Two reports, Latham (1994) and Egan (1998) was commissioned by the UK government and the construction industry to improve the performance of the industry

and building client satisfaction. The result from these reports was a number of recommendations that formed the foundation for the Office of Government Commerce (OGC) “Achieving Excellence in Construction” initiative started in 1999 (Khalfan et al., 2007; House of Commons, 2008). In this initiative, there was a focus on short term “Project Partnering” and long term “Strategic Partnering”, as two of the approaches to create better value for money (OGC, 2007; Thomas & Thomas, 2005). The primary difference between the two contract types is that project partnering is limited to one building project, whereas strategic partnering involves a framework agreement about a portfolio of building projects (Cheng et al., 2004).

Inspired by the results from the UK, several municipalities in Sweden started to look for new ways to reduce construction costs, delivery time and improve quality. In a case study of a strategic partnering project from 2010 to 2014 in Södertälje municipality, Kadefors et al. (2013) found that the total project time from idea to the finished building was reduced by a full year. The researchers also found that the building client, Telge Fastigheter, emphasized quick start-up time, efficient processes and more satisfied employees, as some of their experienced benefits (Kadefors et al., 2013).

## **Methodology**

The study presented in this paper is a longitudinal case study of the development of a public procurement scheme in Denmark. To gather data four methods have been used; tender document analysis, interviews, workshops and a desk study of international cases. The case study research was initiated at the time of the creation of the first instance of a strategic partnership in Denmark, the ByK tender by the Municipality of Copenhagen, in 2016. After this initial experiment, the case study followed the

development of a definition and generally applicable version of strategic partnerships as a procurement strategy. This definition work results in the publication of a “Public Procurement Framework”. To get an understanding of why this work was undertaken and how the definition came about interviews and workshops were used. In the analysis the public procurement framework is compared to two subsequent instances of strategic partnerships, social housing organisations FSB and KAB tenders. Finally, the output of the analysis of the tender documents is compared to international cases. These cases are from Sweden and UK where similar relational contracts to strategic partnerships can be found. Figure 1 is an overview of the research approach and timeline.

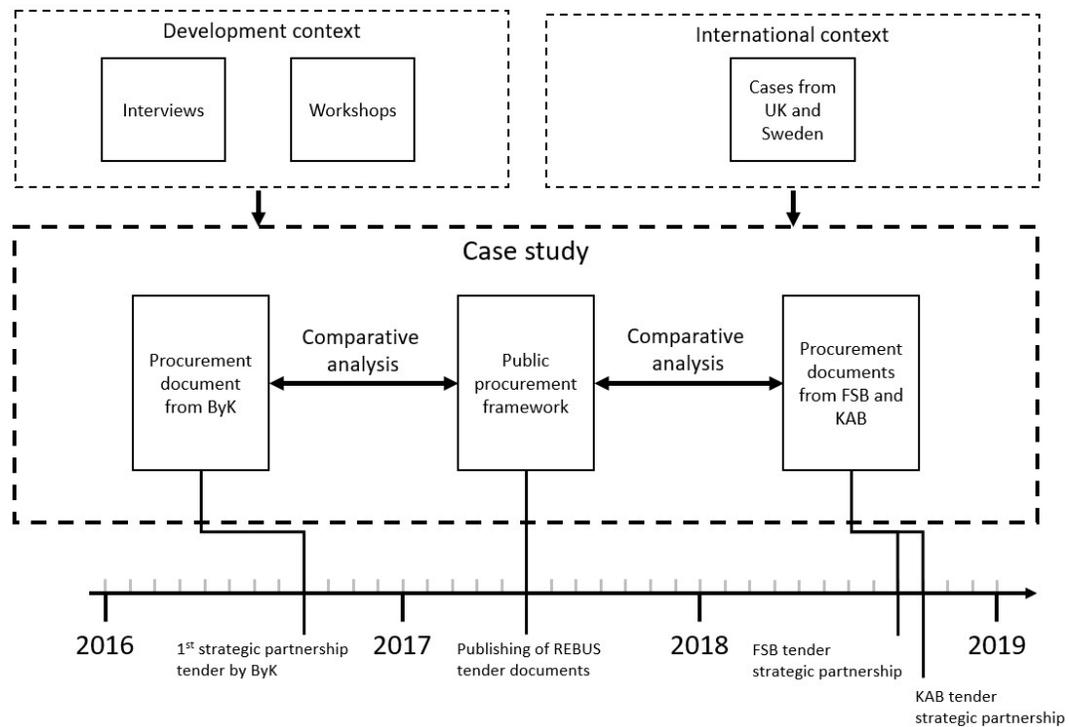


Figure 1 Timeline and overview of research approach

### Case study

Based on the methodology found in Yin (2009) a five component case study was formulated; study question, propositions, unit of analysis, linking data to propositions

and criteria for interpreting findings. The study question is the main research question of this paper. The main proposition for the case study is that public building clients seek to establish new procurement strategies through procurement innovation and that there is a need for specific definitions of procurement strategies. The unit of analysis has been the procurement documents, to understand the specific instance of a strategic partnership. To further understand the development context of strategic partnerships research interviews with practitioners and workshops were used. To link the data to the proposition a comparative text analysis was made using pattern matching. The criteria were that sufficient similarities have to be found between the procurement documents in the case to demonstrate that strategic partnerships as a procurement strategy had been sufficiently defined and replicated.

In terms of selection of the case and tender documents, the focus was on the development of a common procurement framework, which could be used by public building clients. In studying this development, the ByK tender served as inspiration for the development of the procurement framework, developed by the societal partnership REBUS. The public procurement framework was compared to two cases of strategic partnerships made by public housing associations on large building portfolios.

### ***Interview, workshops and international cases***

To get a broad and multifaceted perspective on the procurement strategy, the authors participated in three development workshops of the public procurement framework as active participants. The workshops were structured with a theme for each workshop with a general discussion of the topic, presentations, discussions in small groups and a final summation of the workshops' discussion. The number of participants varied from ten to fifteen and included practitioners from public building clients, architects,

consultants, contractors and suppliers of building materials. The facilitators of the workshops were legal professionals with expertise in construction contract law.

The interviews were conducted as semi-structured expert research interviews as defined by Kvale & Brinkmann (2014). This style of interview has the advantage of being flexible and makes it possible to examine areas that were not known before the interview started if they arise. The interviews made it possible to look into each actor category in the construction supply chain, and individual interviews were made with building clients, architects, consultants, contractors, suppliers of building materials and construction contract specialists.

The desk study was conducted as a scoping study and the selection of the international cases/experiences had the aim of rapidly mapping the key concepts and finding relevant empirical evidence (Arksey & O'Malley, 2005). The cases were selected from Sweden and the UK since the construction industry in these countries has used relational contracts similar to strategic partnerships.

## **Data collection**

### ***Procurement documents***

The overarching case has four main procurement documents. The first document is the procurement document used by ByK to tender two strategic partnerships. The second procurement document is the public procurement framework developed by REBUS. The third and fourth procurement documents are from the tenders of the social housing organisations FSB and KAB. All the tenders concern refurbishment and renovation.

In table 1 the general information about the strategic partnership tenders in Denmark included in the case study is outlined.

*Table 1 Tenders of strategic partnerships in Denmark included in the case study*

Tenders of strategic partnerships in Denmark					
Nr.	Building client	Year	Million EUR*	Type of building portfolio	References
1	Byggeri København	2016	308	School refurbishment	(ByK, 2016)
2	Byggeri København	2016	80	Renovation of cultural-, sports-, social- and healthcare-facilities	(ByK, 2016)
3	KAB	2019	390 - 910	Renovation of social housing estates	(KAB, 2018a)
4	FSB	2019	321	Renovation of social housing estates	(NCC, 2019)

\* Estimated total value

### ***International cases***

Two cases were selected from the UK and Sweden to get the necessary background and context for understanding the Danish procurement framework. One from Salford City Council and the other from Telge Fastigheter with start in 2004 and 2007, respectively (Mallinder, 2006, Munck, 2020).

### ***Interviews and workshops***

As a way to get a deeper perspective on what strategic partnerships, procurement innovation and sustainable renovation meant to the individual companies in the construction industry a number of interviews were conducted with practitioners. The interviews were conducted with some of the same practitioners who participated in the workshops developing the public procurement framework described in the following section. All of the interviews were recorded and transcribed for subsequent analysis and the general meta-data can be seen in table 2.

*Table 2 The seven interviews with date, practitioner type and duration*

Interview number	Date	Type	Duration (H:M:S)
1	25-11-2016	Architect	1:23:04
2	21-02-2017	Contractor	1:25:52
3	23-02-2017	Consultant	1:31:12
4	03-03-2017	Building client	1:36:44
5	14-03-2017	Material producer	1:23:20
6	29-05-2017	Building client	1:24:02
7	02-07-2019	Attorney	0:34:14

Three workshops were conducted as part of the REBUS work with strategic partnerships from August 2016 to April 2017. The attending participants were practitioners from the entire construction value chain and public building clients including the above mentioned interviewees. During the workshops, the authors took research notes and photographed final summations as they were written on a whiteboard.

### **Analysis**

The focus of the analysis is to determine if strategic partnerships are defined and replicated as a procurement practice and how this has been done. In three workshops the definition of strategic partnerships was discussed. Following this work to get a deeper understanding of the perspectives on strategic partnerships seven interviews with stakeholders were conducted. The initial experimental strategic partnership of ByK is compared with the procurement document to the definition of strategic partnership found in the public procurement framework. Subsequently, the public procurement framework is compared to the replication in the form of the KAB and FSB tender document. Finally, this Danish model for strategic partnerships is compared to international cases of similar procurement schemes from the UK and Sweden.



### ***Workshops on the public procurement framework for strategic partnerships***

In the summer of 2016, a series of workshops were planned to develop a generic public procurement framework, which would enable public building client organizations to tender strategic partnerships.

#### *Defining a strategic partnership*

Determining what specifically is meant with a strategic partnership, was a discussion about how the teams should be created and how the role of the building client was supposed to be in the strategic partnership. The choice of this in the procurement framework document was to get Joint Ventures to be prequalified before the main tender round. Another point of discussion was the use of a Design-Build scheme for the building projects, which put the contractor as the main part of the legal agreement between the building client and the consortium or Joint Venture. It was seen as a potential loss of control, especially by the building client, over the quality of the final building project.

#### *Creating stability with strategic partnerships*

The second question, which was; “what is the goals of a strategic partnership”, had many different answers. It depended on which company or building client organization was asked. A common goal for all was the need for stability, but the reasons for this also varied. The building client wanted stability in terms of quality and budget security and the companies had a wish for stability in terms of work and production flow. From the material producer and the contractor point of view, a very attractive feature of the strategic partnership was the possibility to be involved in the early stages of the design process. To accommodate all of these early inputs, the architects and engineers pointed

out that it was important to have a clearly defined process structure and a clear plan of who would contribute with what in which part of the project.

### *Risk management with strategic partnerships*

A topic that also got a lot of attention from the workshop participants were risk allocation. In a building context, risk can be seen from many perspectives. The building client has capital, which needs to be spent to get a building of equal or better value compared to the capital. The portfolio management aspect in strategic partnerships is seen as a way for the contractor to reduce risk, in terms of investments in specialized machinery or capabilities and scheduling flexibility. The material supplier also sees some of the same benefits of early design involvement. One of the benefits of early involvement is that the material producer can suggest design decisions that reduce specialized products needed for projects. The consultants, architects and engineers, have a process perspective and in terms of risk, they can invest in standardization of processes and in this way reduce the design risks inherent when using untested designs.

### *Interviews to understand strategic partnerships in the construction value chain*

To get an understanding of what strategic partnerships is for the different actors in the construction value chain, a number of interviews were conducted. All the interviews were with practitioners who were not participating in strategic partnerships at the time of the interview. The interviews were conducted to test the hypothesis that there did not exist a clear and accepted definition of strategic partnerships in the industry. The focus of the interviews was also to establish a knowledge baseline and to examine the preconceived notions the different stakeholders had.

The interviewees expressed a general lack of a clear definition of strategic partnerships and when describing the relationship there was a great variety in the description of what a strategic partnership is. This is as expected when this concept has not manifested itself in the industry many times, and the level of direct first-hand experience is limited or non-existent.

When asked if there are technical, administrative or personal barriers to overcome to have a successful strategic partnership, personal relations are rated the most important. This is related to the level of trust, which the interviewees feel is necessary for the partnership to function. One interviewee working for a large contracting company explains it like this (all citations from interviews and documents in Danish were translated by the authors):

“...neither we nor the suppliers are used to this, you are used to, quote un-quote cheating each other [brief pause], so it is brand new when we come and talk strategic partnerships with the suppliers, uh they don't get it, uh and in the back of their minds all the time is; am I trying to cheat them?”

To overcome these barriers personal relationships needs to be created, which can support the partnership (Maurer, 2010).

Finding the right type of company to participate in a strategic partnership is also a topic, which several of the interviewees talked about. There is a culture and a size component that needs to match between the companies. The cultural match was expressed as a match between the values and goals of the companies. In terms of size there is a very big range of company sizes in the construction industry, from a single person to several hundred thousand employee companies, and everything in-between. For the strategic partnership to be equal between the companies there needs to be a size similarity between the companies.

The interviews gave several insights into the possibilities and challenges that the different stakeholders identified regarding strategic partnerships. But the need for clear definitions is evident and in the following section, the translation from initial experiment to general public procurement framework is examined.

### ***The definition of strategic partnerships in the public procurement framework***

The procurement framework was developed to enable public building clients to tender a building portfolio in a strategic partnership. This means that the documents are made to comply with both Danish and EU rules regarding public procurement of building services.

#### *Tendering document*

The tendering document describes the process of tendering which follows the format described as “Competitive procedure with negotiation”, which is a standard EU procurement method. Before the prequalification round, the building client invites all interested parties to an information meeting. The tendering process has a prequalification round where the building client prequalifies 3-5 Joint Ventures based on:

...an assessment of which suitable applicants document the best and most relevant experience with comparable forms of collaboration / processes and projects.

(REBUS & DLA Piper, 2017b)

As a guideline, the weight of the different evaluation criteria is 60% on relevant experience with comparable forms of collaboration/processes and 40% on experience from relevant projects. Apart from these evaluation criteria, there are standard economic

and legal requirements the applicants must live up to in order to be eligible to prequalify.

Once the prequalification round is over the applicants are asked to submit a tender. The evaluation of the tenders follows the criteria shown in table 3.

*Table 3 Criteria for tender evaluation in the procurement framework [adapted from REBUS & DLA Piper, 2017b)*

Criteria	Weight	Sub-criteria	Weight
Economy	25%	<ul style="list-style-type: none"> <li>• Price for base organization*</li> <li>• Hourly rate for consultants</li> <li>• Overhead</li> <li>• Deduction/additional rates to Molio Prisdata**</li> <li>• Internal technical consultancy***</li> </ul>	<ul style="list-style-type: none"> <li>• 10%</li> <li>• 15%</li> <li>• 20%</li> <li>• 50%</li> <li>• 5%</li> </ul>
Base organization* and other organization and personnel	20%		
Understanding and cohesion	15%	<ul style="list-style-type: none"> <li>• Understanding</li> <li>• Cohesion</li> </ul>	<ul style="list-style-type: none"> <li>• 70%</li> <li>• 30%</li> </ul>
Optimization	25%		
Construction technical solutions	15%		

\* The base organization is the organization, which takes care of the portfolio planning and other functions that are not directly attributable to the individual projects.

\*\* Molio Prisdata is a Danish construction price database with prices on individual building materials, elements and services.

\*\*\* Internal technical consultancy is defined as all consultancy required during construction.

After the tender has been submitted, the building client will invite the applicants to a single or several rounds of individual negotiations where the building client can give feedback on the strength and weaknesses of each part of the tender. The applicants are asked to resubmit and to give an oral presentation of the tender. After this, the tenders are awarded a final score and a winner is found.

### *Framework agreement*

The framework agreement is the foundation of the strategic partnership. It describes the governance model, the structure of the workflow and the conflict resolution scheme. As an example:

2.7 Both parties are obliged to ensure that knowledge for the benefit of the strategic partnership is continuously exchanged between the strategic partner and the Client's organization and that both parties have the necessary capacity and maturity to realize the strategic partnership. (REBUS & DLA Piper, 2017a)

The structure of the framework agreement is such that it has a specified duration and for each project, a Design-Build agreement is signed. The partnership ends when all the projects are completed; something that can continue multiple years after an e.g. four-year period, which is the time frame where new Design-Build agreements can be signed. The governance structure for the strategic partnership consists of a steering committee, which has participants from the building client and participating companies. To mitigate the effects of conflicts or disagreements, which will inevitably happen, a six-step conflict resolution process is put in place. The first step is at the project management level in the individual project. The second is at the operational management level. The third is at the steering committee level, while the fourth and fifth step uses a mediator and an independent evaluator, respectively. The sixth and final step is a legal resolution bringing the disagreement to the arbitration board. The steering committee is responsible for strategic management of the partnership, revisions of goals, organization and processes, approving overall project goals, evaluate performance and conflict resolution at level 3. Under the steering committee is the operational management, which also consists of members from the client organization and the companies. The operational management has responsibility for portfolio

management, the start of new projects, economic assessment of projects, knowledge sharing and conflict resolution at level 2. In each project, there is a project group with the participation of project managers from the building client and one or more project managers from the companies. Their task is to manage the project, ensure that the specific goals are met and actively participate in development and innovation across projects.

Each project is divided into four project phases from zero to three; clarification of needs, design brief, developed design and budget estimations, and finally technical design, construction and handover.

Principles such as open books, lock-in of overhead at phase 2 and holistic risk management are used to ensure that budget and quality demands are met. Changes to the project which affects the economy, scope, quality or time, are discussed analysed and implemented jointly by the building client and the strategic partner. A part of the construction budget is earmarked as a risk budget, and a specified percentage will be paid of this budget, split between the project participants if a project is completed without using this risk budget.

In section 21 the upstart and maintenance of the strategic partnership is described in detail. This is done to ensure the appropriate level of integration between the strategic partner and the building client organization. Joint education programs, establishing a collaborative organization, common Key Performance Indicators, development strategy and meeting structure are used to facilitate the collaboration.

### ***The framework agreement of the ByK tender compared to the public procurement framework***

The building client organization ByK is the building client organization in Copenhagen

Municipality with approximately 200 building and renovation projects at any given time (ByK, 2020). The analysis of the ByK framework agreement with respect to the public procurement framework was done for each of the 35 sections found in the two framework agreements. In the total text of the two framework agreements, there are 46% identical sentences and sections. This analysis shows that the developed public procurement framework is a very close replication of major parts of the framework agreement from the ByK tender. The public procurement framework has been developed for common use and as such does not contain some of the building client specific sections of the framework agreement from the ByK tender. Both framework agreements contain the same overall structure and while some of the sections deal with procurement issues that are of a general nature to public building clients in Denmark, like requirements to ICT, others are very similar and this cannot be explained by the normal practice of procurement. These are sections like “Upstart and maintenance of the strategic partnership”, “Open books” and “Collaboration and common goals”. In the sections other wording could and probably would have been used had the public procurement framework not deliberately been based on the bespoke contracts developed for the ByK tender.

### ***Replication - The public procurement framework compared to the FSB and KAB tenders***

To examine if the definition of strategic partnerships made in the public procurement framework could be replicated by public building clients, an analysis of two social housing organisations procurement documents was made.



### *The KAB tender compared to the public procurement framework*

Less than two years after the public procurement framework was published, two tenders of strategic partnerships were made. One of them was made by KAB, which is an administrative housing organization consisting of 33 social housing associations, 3 dormitories, 10 independent housing organizations and 4 other institutions, with approximately 60.000 residential units combined (KAB, 2018b). The building client wants to have one strategic partner consisting of a conglomerate of companies and the tender uses “Competitive procedure with negotiation” and MEAT evaluation criteria. As tender evaluation criteria, KAB uses four out of the five criteria seen in table 5, from the public procurement framework, with “Construction technical solutions” not being included. They have used the following rating; Economy 30%, Base organization and other organization and personnel 20%, Understanding and cohesion 20% and Optimization 30%.

When analysing the framework agreement, it is 53% identical in text to the framework agreement in the public procurement framework. The differences are not in terms of the overall structure and setup of the agreement, but building client specific issues. One area is an emphasis on tenants, tenant involvement and tenant communication. Another difference is an update to the juridical framework, because the “General conditions” for construction contracts in Denmark, the AB-system, was revised by public authorities and representatives from the construction industry in 2018. Differences are found in the duration of the framework agreement which is a 4+2 year agreement and the project phases are the same as the public procurement framework with the slight modification to adapt to the decision structure in KAB (KAB, 2018a). Since KAB and the organizations which it represents in major renovation and new construction projects apply to Landsbyggefonden, a national foundation to support

social housing, this means that there is an application structure in place. This application process is incorporated into the strategic partnership workflow. The six-step conflict resolution system described in the previous section is identical in the KAB tender as is the section about upstart and maintenance of the strategic partnership.

### *The FSB tender compared to the public procurement framework*

The second replication is the building client FSB's tender of a strategic partnership, a social housing association in the Copenhagen area with 13.000 housing units. These consist of family-, youth- and elderly-housing and is the largest social housing association in Copenhagen (fsb, 2020).

In a superficial analysis of the framework agreement in FSB's tender, it is easy to see the link to the public procurement framework. The front page is identical in colour scheme, wording and even typeface. The building client has added a logo in the bottom right corner and updated the date. Full-text analysis shows that there is 48% identical text with respect to the public procurement framework. Looking at the overall structure of the agreement there are four sections out of 37, which have been changed or added. The sections added are GDPR and confidentiality, conflict forum and independent assessor, and the section removed is risk budget. In the section on collaboration and common goals, there is like in the KAB tender a focus on the tenants and a positive experience and outcome for them. There is also a new separate section describing the development of a common evaluation model to evaluate the progress of the strategic partnership and the projects. Like in the KAB tender the total duration of the contract period is 4+2 years and it is specifically stipulated in a section about the partner's specific tasks and assignments that FSB will establish a common workspace (project office) for the strategic partnership. The four-phase model for workflow is the

same with minor revisions as well as the use of open books. The use of an incentive structure where the overhead is fixed at phase two in the workflow is also used and the section about project changes is identical to the public procurement framework. There are significant changes made to the section about delays where the public procurement framework has a multistep process where, if a fine is paid by the strategic partner, it can be repaid under certain conditions. The framework agreement in the FSB tender has a simple fine system for delays with no possibility for repayment, but it is stipulated in the section that it will only in certain circumstances resort to fining the strategic partner. The section about GDPR and confidentiality which is an addition to the framework agreement and is not found in the public procurement framework describes how data security encompasses the daily work of the building client and the strategic partner and that it extends to the tenants of the building client. The section about conflict resolution uses a seven-step process, which closely resembles the six-step process from the public procurement framework, but with the addition of a conflict forum. This conflict forum is at step 3 just before the steering committee at step 4 and this conflict forum consists of a representative from the strategic partner and the building client. The steps involving mediation and the independent assessor is identical to the one found in the public procurement framework.

### ***Comparison of the Danish and international cases***

The reason for including cases from the UK and Sweden in the data collection comes from the history of relational contracts in these two countries described in previous sections on strategic partnerships. The main organizational difference between the Danish cases and the Swedish and UK cases is that in the Danish cases the strategic partner is just one contractor with a team, whereas in the Swedish and UK cases

multiple contractors with teams are used. The multiple contractors and teams are used depending on the specific type of project. In the Danish cases, it is the same contractor and team who are allocated all the projects in the portfolio. In the ByK tenders, there was only one building client but two framework agreements were created, one for each building portfolio with one strategic partner for each portfolio.

Another area where the Danish cases differ from the Swedish and UK cases is the use of systematic conflict resolution. The six or seven step conflict resolution system allows for conflicts being resolved without resorting to litigation without the need to completely exclude it. This systematic approach committed to by the building client and the strategic partner has not been found in the international cases. The conflict resolution system in the Danish model is binding and does not preclude litigation since this is the last and final step.

The general attributes of relational contracts are observed in both the Danish and international cases. These attributes are systematic communication and common positive incentives to optimize and a focus on creating common goals and values.

### ***Analysis summary***

From the analysis of the procurement documents, it can be seen that from the experiment (ByK tender) to the definition (Public procurement framework) and the replication (fsb and KAB tenders) of strategic partnership there are clear consistent attributes. These are innovative procurement strategies such as; systematic conflict resolution including mediation and litigation and joint education programs of employees.

From this, we can with high confidence say that a Danish model strategic partnership has been identified as a procurement innovation, that it has a robust definition and has been replicated.

## **Discussion**

The research is based on data from a single country (Denmark) in the EU. This makes the results of the research difficult to generalize to other countries with different social, economic and construction traditions. While international cases are used to compare to the findings, these are also from other European countries. Further research to evaluate the general nature of the results could focus on subjects such as power distance, digitization level and the impact of market size.

## ***Data collection***

The four-way data collection strategy, workshops, interviews, tender document analysis and desk study, was used primarily to create triangulation of findings and to have as rich a dataset as possible.

Workshops have been found to have a wide adoption; both by practitioners and academics. There is however a lack of rigorous scientific definition of the role of the researcher and the analysis of the data. As such, workshops should be used in a mixed method approach together with other empirical methods (Ørngreen and Levinsen 2017).

Gaining insights from cases is always a dilemma between creating a valid and in-depth description of the individual case and the desire to extract generalizable results. The creation of a collection of case descriptions, which covers all possible states and cases that show general trends, is difficult if not impossible (George & Bennett, 2005). The case selection hides the true extent of the use of relational contracts and partnership

used in the construction industry in Denmark, but to do a full analysis was deemed too great a scope for a single paper. This may be an avenue of research that could be undertaken in the future.

## **Conclusion**

Using inspiration from experimental procurement of a strategic partnership, a generic procurement framework suitable for public building clients was developed with industry and public building client collaboration. The collaboration resulted in a new procurement standard – “The Danish Model of Strategic Partnerships”. This definition of a public procurement framework was used by other public building client organisations to replicate the procurement strategy. A standard like this is useful not only for building clients, who wish to implement a tested procurement strategy, but also enables cross building client benchmarking and development. This research contributes to the further development of relational contracting in construction and is a unique case study view into the development of procurement innovation to support sustainable building renovation.

As a theoretical contribution, in the longitudinal case study three phases have been identified in the development process; experiment, definition and replication.

The Danish model of strategic partnership consists of a framework contract with one strategic partner and this strategic partner is a conglomerate of AEC companies. The strategic partnership entails the creation of a suitable portfolio of building and renovation projects and subsequent portfolio management. The inclusion of best practice systematic conflict resolution approach, a flexible public procurement framework and full-scale implementation have shown that strategic partnerships are accessible to public building clients in Denmark.

The research has been carried out in Denmark and cross referenced with cases from other European countries. This will possibly limit the applicability of the results to other areas and markets. Since the results are derived from a case study, and although several data sources have been used, it is not possible to declare definitively how development of relational contracts should be done. Further research is needed to answer these aspects.

Strategic partnerships can support more sustainable renovation by enabling the building industry to collaborate on novel and complicated solutions. It also creates a platform to discuss many different sustainability parameters and can deliver high quality buildings, suitable for the global climate challenges facing the world.

### **Acknowledgements**

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### **Disclosure statement**

There has been no conflict of interest related to the research presented in this paper.

### **Data availability**

The public procurement documents which have been part of the empirical material has been publicly available through the iBinder portal (iBinder.dk) and rebus.nu. The data from the workshops and interviews are of a personal and sensitive nature and can only be accessed by directly contacting the corresponding author and after subsequent obtaining written consent from the participant(s).

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## APPENDIX B

Paper - Berg et al. 2022b

*Understanding transactions: A maturity model for construction supply chain relationships*

# Understanding transactions: A maturity model for construction supply chain relationships

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## Abstract

As supply chain management (SCM) becomes an integrated part of the construction industry, it becomes a challenge to choose an appropriate governance mode for different supply chain relationships. Using the best suited governance mode is very important to increase the chances of success of a construction project. This paper proposes a new model to support building clients and companies procuring building services. Data from workshops with practitioners together with practitioner surveys informed the development of a new Construction Supply Chain Transaction maturity model (CSCT). The model dimensions were identified using triangulation and existing models in literature. The CSCT maturity model has four levels of maturity; price, quality, project partnering and strategic partnering. The four levels are then identified by Key Attributes on seven value dimensions and seven complexity dimensions. Using more mature governance modes for construction projects can reduce costs, conflicts and improve performance. At the same time, using less mature models can reduce switching costs and improve transparency. The CSCT maturity model provides a new framework to choose where to apply which governance mode to benefit a specific construction project taking into account both value and complexity.

Keywords: Construction, Maturity model, supply chain, governance

## Introduction

The construction industry has in the last several decades been plagued by stagnating productivity (Nielsen et al., 2010, Naoum, 2016, Seadon and Tookey, 2019). This has led to a number of interventions by implementing governance changes to alleviate the perceived shortcomings of

the construction industry (Zhang et al. 2020, Papajohn et al., 2020, Guevara et al., 2020, Lenderink et al. 2022, van der Krift et al. 2021). Implementing these changes to procurement and governance in construction projects is not trivial and requires new skills and capabilities (Tran et al. 2020). Recent research has found that prior collaborative experience, multidisciplinary teams, early contractor involvement, project attractiveness, appropriate evaluation criteria and management of the procurement process are important for success in a construction project (You et al. 2020, Ibrahim et al. 2021, Papajohn et al. 2020, Guevara et al. 2020, Calahorra-Jimenez et al. 2020, Manu et al. 2021). All of these are parts of relational contracts which have been developed for the construction industry supply chain.

The difficulties the industry faces makes it a relevant subject for researchers, and some have proposed models that supports construction supply chain management efforts (Behera et al., 2015, Papadopoulos et al. 2016, Van Lith et al. 2015). When analysing the existing literature it is however not possible to find many instances of supply chain management models which address the procurement reality of the construction industry and relational contracts. One such model has however been identified; the “Supply Chain Relationship Maturity Model” (SCR) developed by Meng et al. (2011). As will be shown in later analysis the challenge with using the SCR model is that it only contains a value dimension and as such not accounts for the complexities in mature procurement relationships. As a result this leaves a gap which this paper will provide an answer to, through answering the following research question.

“How can a maturity model of procurement relationships in construction be created, in such a way that it takes into account both the positive and negative attributes of using mature procurement relationships such as strategic partnerships?”

The reason for developing this model, and why it is needed now, is that the types of supply chain relationships the SCR model describes are now found in multiple European countries (Kadefors et al., 2013, Frederiksen and Gottlieb 2019). The proliferation of relational contract types such as partnering, strategic partnering, alliancing, Integrated Project Delivery and strategic partnerships, has the potential to improve construction projects and outcomes, but they are not suited to all project types (Latham 1994, Egan 1998, NAO 2005, Engebø et al. 2020, Berg et al., 2022). This leads to the need for tools to understand the positive and the negative aspects of the different procurement strategies in order to find the optimal strategy for a particular project. While this is especially important for building clients, procurement strategies are important for companies in the entire construction value chain.

## Theoretical background

To develop the model in this paper three key areas of theory has been used; Maturity models, transaction cost economics and parsimonious models. In the following sections these three areas of theory are defined to create a foundation from which the model can be developed using empirical data.

### ***Maturity models***

Maturity models were first developed in the beginning of the 1990'ies to assess the capabilities of software contractors (Paulk et al. 1993). The model was called the Capability Maturity Model (CMM). Maturity models have since been developed to analyse a number of different processes and industries (Santos-Neto and Costa 2019, Iversenet al. 1999). There are two categories or perspectives which a maturity model can have; a life cycle perspective or a potential performance perspective (Wendler 2012). In a maturity model with a lifecycle perspective the

movement from one step to the next comes organically from an initial condition of immaturity and the process over time matures to the subsequent steps ending with a fully mature process.

In contrast a model using the potential performance perspective the process does not progress through natural maturity but through deliberate decision. The progression happens when the value of maturing outweighs the complexity. The potential performance perspective can be used when modelling systems where each step of maturity have value superior to the previous step (Wendler 2012).

In a recent literature review of the field 12 maturity models related to construction processes and engineering were identified by Santos-Neto and Costa (2019). There are a number of maturity models developed to look at the general purchasing maturity, but the general nature of these only go so far in explaining the specific practices used in the construction industry (Potage 2017, Hermans 2016, Langston and Ghanbaripour 2016). This is why the model developed in this paper takes its starting point in the SCR model developed by Meng et al. (2011) which focus on the procurement reality of the construction industry.

### ***Transaction costs and parsimonious models***

For the model presented in this paper the foundational theory is Transaction Costs Economics (TCE). In TCE the focus is on describing the associated costs with a transaction which a company or organization makes, and how to best structure these within and outside an organization (Williamson 1981). The costs come in two categories, the direct cost of technology and production and the transaction costs associated with governance like planning, adapting and monitoring. To get a complete picture of the costs associated with a given transaction both types of costs need to be included. The types of governance which TCE uses to assign to different types of transactions are; market, hybrid and hierarchy (Williamson 2008). A market and



hierarchy are the extremes of the spectrum and hybrids are in-between these two polar modes of governance. A market transaction is a simple exchange between a buyer and a seller mediated by an open market with many buyers and sellers. In a hierarchy by contrast the transactions are mediated through administrative control in an organization and is well suited to cooperative adaptation. When making a TCE analysis it is interesting how many transactions are mediated by markets and hierarchies and the relatively low number of transactions mediated by hybrids (Williamson 1979).

The concept of parsimonious models, or models which with the fewest possible variables explains the data reasonably well, is used in many areas of science (Vandekerckhove & Matzke 2015, Tenenbaum & Filho 2016, Daganzo et al. 2012). The maturity model developed in this paper uses this principle and as such the value and complexity dimensions are not created to describe all the characteristics between the different types of company relationships, but enough to be able to make a reasonable analysis. This makes the model practical to implement, while at the same time enabling a reasonably accurate assessment of which type of relationship is appropriate in a given transaction.

## Analysis of the SCR model

The SCR maturity model describes four distinct types of buyer-supplier relationships in the construction industry; price competition, quality competition, project partnering and strategic partnering. These four levels are analysed using an analysis matrix seen in table 1.

Table 1 Analysis matrix of the SCR model (Meng et al. 2011)

Main criteria	Subcriteria	Level 1	Level 2	Level 3	Level 4
Procurement	Selection criteria	The lowest price	Cost and quality	Multicriteria from short-term perspective	Multicriteria from long-term perspective
	Procurement route	Single-stage tendering	Two-stage tendering	Negotiation or tendering	Direct negotiation
Objectives	Form of contract	JCT	JCT/NEC	NEC/PPC 2000/JCT CE	NEC/TPC 2005/JCT CE/Bespoke contract
	Objectives alignment	Only self objectives	Mainly self objectives	Mutual objectives in a project	Mutual objectives in the long-term
	Benefits	Win-lose	Win-partial win	Win-win in a single project	Win-win in the long-term
Trust	Continuity of work	No continuity of work	Prospect of future work through tendering	Preferred suppliers	Guarantee for future work
	Type of trust	Contractual trust	Competence trust	Short-term goodwill trust	Long-term goodwill trust
Collaboration	Confidence in others' behavior	Little confidence	Some confidence	Much confidence	Full confidence
	Monitoring others' work	Checking and double checking	Checking somewhat reduced	Checking greatly reduced	Checking almost unnecessary
	Working relationship	Confrontation or arms length	Limited cooperation	Collaboration	Close collaboration
	Culture	Mutual blame	Self defense	Abandon of blame culture	Problem solving focused culture
Communication	Mutual help	No support for the weaker	Support only with the issues related to self-interest	Often support for a weak partner	Always support for a weak partner
	Information exchange	Little information is exchanged openly	Some information is exchanged openly	Much information is exchanged openly	Most information is exchanged openly
Problem solving	Sharing learning	No sharing learning and innovation	Little sharing learning and innovation	Sharing learning and innovation	Continuous sharing learning and innovation
	Cost data transparency	No cost transparency	Little cost transparency	Open book costing between two parties	Open book costing throughout the whole chain
	Early warning	No risk identification, no early warning	Informal risk identification, no early warning	Early warning between two parties	Early warning throughout the whole chain
Risk allocation	Effectiveness	Problems often lead to disputes	Problems sometimes lead to disputes	Many problems are timely resolved at the lowest level	Most problems are timely resolved at the lowest level
	Avoidance of recurrence	Problems often recur	Sometimes problems recur	Few problems are repeated	Rare problems are repeated
Continuous improvement	Risk sharing	No risk sharing	Limited risk sharing	Risk sharing greatly increased	Common practice for risk sharing
	Allocation principle	Risk is always allocated to the weak party	Risk is often allocated to the weak party	Risk is allocated to the party best able to manage it in a project	Risk is allocated to the party best able to manage it in the long-term
Continuous improvement	Balance of risk and reward	No rewards for the party taking the risk	Some rewards for the party taking the risk	Often appropriate rewards for the party taking the risk	Always appropriate rewards for the party taking the risk
	Joint effort	No joint effort for improvement	Limited joint effort for improvement	Joint effort for better ways of working	Continuous effort for better ways of working
	Performance measurement and feedback	No common measures; No formal feedback	Limited common measures; irregular but formal feedback	Common measures; regular and formal feedback in a project	Common measures; formal, regular, and continuous feedback
	Incentives	No incentive	Informal incentive	Single incentive	Multiple incentives

Along the eight criteria with 24 sub-criteria the model captures the value of creating more sophisticated buyer-supplier relationships. The issue with using this analysis matrix is that it only accounts for the positive, or value, aspects of moving to a higher maturity level. It has a missing dimension, which prevents this model from becoming a practical and useful tool for analysing the entire construction industry supply chain. The ability to analyse the entire value chain was pointed out by Meng et al. (2011) as a point of possible further research.

This is why this paper proposes adding the complexity dimension of the maturity model. At the same time the maturity model type is proposed changed from a capability maturity model, which has a lifecycle perspective to a potential performance perspective. The reason for the change is that while some aspects of the relationship between the buyer and supplier may change over the project lifecycle, the overall procurement strategy does not change since this is set down in the initial contract. Each maturity level also has a procurement strategy which inherently has value in some circumstances. The choice of procurement strategy should therefore be made with a potential performance analysis in mind, and an evaluation of which maturity level is appropriate for a given transaction.

This is in line with the thinking of Williamson (2008) that there should not be an overreliance on one type of procurement strategy or supply chain relationship. While the value part of a maturity model describes which benefits can be expected when going from a lower level to a higher level of maturity, the complexity dimension shows the associated challenges by doing so.

## Research approach and methods

To develop the model an abductive approach was used as described by Tavory and Timmermans (2014). This research method is distinct from inductive and deductive research approaches, since

it relies on many instances of empirical study, both qualitative and quantitative, in order to formulate theoretical propositions. It does however not seek to make judgements on causal connections since the subject may not be directly observable, however the abductive approach seeks to develop plausible descriptions.

In order to have sufficiently nuanced data to cover the subject, a mixed method approach was used. The research perspective of critical realism together with the empirical data from workshops and questionnaires create the theoretical and empirical framework from which the model has subsequently been derived (Saunders et al. 2008, Ørngreen and Levinsen 2017).

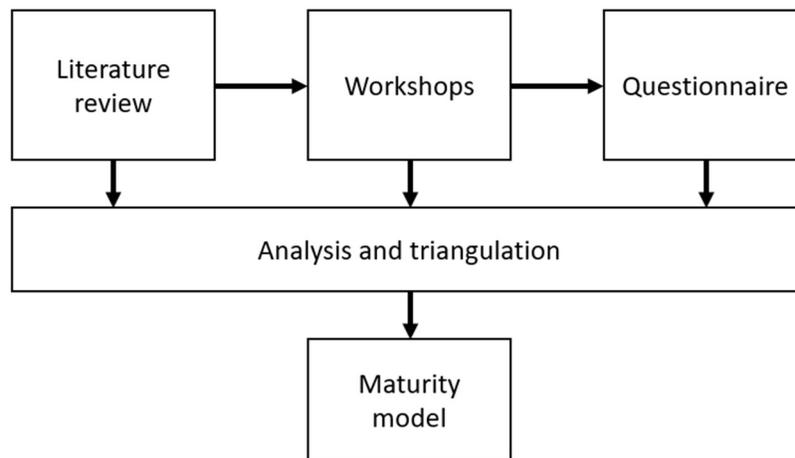
### ***Research method***

As described in the previous section a mixed method approach has been used in the empirical data gathering for this research. This is done to reduce the inherent bias that comes with one particular way of gathering data (Greene et al.1989). First, a number of existing construction procurement models were identified in literature. Second, to get a deep understanding of the procurement relationship reality of the construction industry a number of workshops were conducted with practitioners from the entire construction industry value chain. Finally as a quantitative data source and as a more focused perspective on the differences in procurement relationships, a survey was developed and distributed to practitioners with and without prior experience with mature procurement relationships.

To ensure the developed model is sufficiently plausible and reliable the data was triangulated. In this way the final model only contains elements which were present in several data sources (Carter et al. 2014, Patton 1999).

## Model creation with practitioner focus

One of the guiding principles behind the model created in this paper is that it needs to support the practitioners in the construction industry and their current and future mode of practice. A workflow was developed, see figure 1, to ground the model in theory with a subsequent focus on empirical data from practitioners.



*Figure 1 The workflow for developing the maturity model*

### **Workshops**

Five workshops were conducted over a two year period and had a number of different setups depending on the specific topic of the workshop and the number of attendees. The themes, duration and location can be seen in table 2. The three small workshops conducted with 10 to 15 participants were exploratory in nature. They were organized as discussions with breakout sessions in minor groups to look into specific topics. The two workshops with 25 or more participants had a more ridged structure with questions and discussion topics supplied by the facilitators, and participants were put into predetermined groups. In the large workshops the topic and structure of the workshop was briefly introduced by the facilitators and the subsequent group work was at the end summarized by participants from each group. In all the workshops the

goal was to have perspectives from the entire construction value chain, and the group formation and the individual workshop participants were selected accordingly.

*Table 2 Theme, number of participants, date, duration and location of the workshops*

Theme	Participants	Date	Duration (H:M)	Location
Challenges in construction	<15	20-09-2016	5:00	Copenhagen, Denmark
Relationship change when moving from market to hybrid governance	<15	05-10-2016	3:30	Copenhagen, Denmark
Changing procurement strategy from a building client perspective	<15	26-11-2018	7:00	Lyngby, Denmark
Possibilities and barriers to changing to hybrid governance	>40	19-09-2017	7:30	Aarhus, Denmark
Effects, instruments and boundary conditions in hybrid governance	>25	11-12-2017	3:00	Copenhagen, Denmark

Strategic partnering and how to approach this way of organizing the construction industry, was an overarching theme of all the workshops. In Denmark this way of procuring buildings is a recent phenomenon and the first instance of such a procurement scheme in practice is found in 2016 (Frederiksen et al., 2019). By contrast project partnering has been found in construction projects in Denmark as far back as 2001 (Jensen 2007, Haugbølle et al. 2018). This addition of a new hybrid governance strategy meant that there were interest from practitioners to learn about and engage in conversations about this new hybrid governance procurement strategy.

The small workshops

In the first workshop on “Challenges in construction”, the goal was to identify problems, which the participants perceived to be solvable using a more sophisticated procurement strategy. The participants of the workshop were representing companies from the construction value chain participating in a societal partnership with the goal of supporting innovation in the construction sector. A total of 14 challenges were identified and subsequently discussed and of these four were highlighted as being most important; Communication, Productivity, Tenders and competitions and Lack of repetition of teams.

The second workshop, “Relationship change when moving from market to hybrid governance”, focused on the deeper relationships that are affected when building client and companies engage in hybrid governance structures. Following on the point of communication from the first workshop one of the insights was that in the early design phase, since many of the participants in a hybrid governance do not have their main expertise in design, if not managed correctly the construction process could take focus away from the design phase. Another point on communication is that changing procurement strategy may “seem easy”, but that it entails a large number of changes to the day to day operation which may not be immediately obvious.

On the productivity aspect, it was highlighted that the ability to transfer funds from one project to another is a great advantage if this strategy is employed in a portfolio. It enables the consortium to spread the financial risk across several projects and enables the holistic management of resources in the portfolio. To support greater productivity the “open books” approach was also mentioned. Open books enables everyone to get a realistic picture of the cost drivers in a project and to see if a proposed change will negatively or positively impact the

overall cost. It was also pointed out that the open books should not become the focus on price negotiations, since this will adversely impact the suppliers.

The tender practices were also discussed and it was made clear that if a new procurement scheme should fulfil its full potential, it was important to link the selection and award criteria to the project or portfolio. The more comprehensive selection criteria was also deemed a prime candidate to introduce new sustainability and environmental criteria into the success criteria of a building project.

In terms of the repetition of teams, when using Design-Build (DB) contracts for the building projects it was highlighted that the focus had to shift away from the contractor. Where a traditional DB contract has the contractor as the focal point for all companies in the design and construction process, in a hybrid governance mode this has to become an equal partnership between the companies in the supply chain and the building client. The cross company and interdisciplinary nature of the teams were also seen as a way to make recruiting new talent easier, by providing a more dynamic and integrated work environment.

In the third small workshop, “Changing procurement strategy from a building client perspective”, the focus was on a specific building client and their view on changing procurement strategy. The client was subject to public procurement rules and had a wish to innovate and evolve as a building client organization. One of the core concepts which the building client representatives stressed was the organization’s ability to reflect on own practices and to handle uncertainty when changing procurement strategy. The building client saw being able to execute “Competitive procedure with negotiation”, a technical name given by the EU to a procurement strategy, which has been employed to tender strategic partnering in Denmark, as an important



capability. Another was the capability to deliberately develop relationships and operations in long term commitment with suppliers, to set goals and measure the progress towards these.

The large workshops

In order to get a wider view and input from the construction industry more broadly, two workshops were created with an open invitation to participate. The first one with the theme “Possibilities and barriers to changing to hybrid governance”. The participants were divided into six groups and given the tasks to discuss and articulate the possibilities and barriers to create strategic partnering or partnering like building practices. In each group there were deliberately a mix of backgrounds of the participants and they were asked to give feedback for each of the two parties; building client and the AEC companies. All of the answers were collected by the facilitators, transcribed and analysed by the authors. From the data a number of general values and complexity parameters were extracted. They can be seen in table 3.

*Table 3 Value and complexity parameters identified by the participants in the workshop*

	Value	Complexity
Building client	Budget improvement/security	Mistrust
	Quality	Lack of competences and culture
	Collaboration/repetition	Small portfolio
	Improved time	
AEC	Stability	Exclusion
	Standardization	Profitability
	Stable teams	Change in power dynamic
	Early involvement	
	Economy and resources	
	Development	

In the second large workshop with the theme “Effects, instruments and boundary conditions in hybrid governance”, the practitioners were split into four groups which had a theme each; time & money, quality & architecture, innovation & learning and organization & collaboration. They were asked to make explicit statements on the effects of new procurement schemes like strategic

partnering. To achieve these effects they were asked to identify instruments which could be used to achieve the effects and finally which boundary conditions influenced the instruments.

From these three layers a number of common factors were extracted in the subsequent analysis of the responses. In the boundary conditions, out of 49 total identified, two were identified across the four themes; procurement practice and the budget. That the procurement scheme is an important boundary condition seems to validate the focus of this paper on creating a model which focuses on this subject. As for the instruments discussed by the participants, a total of 66 were collected, and two were found in each response group; common culture and early involvement. In the end these boundary conditions and instruments should support the desired effects and 21 were identified by the participants.

Based on the data from the workshops a questionnaire was developed to get a more general data set. Furthermore the information from the workshop was used to validate the value dimension in the maturity model developed in this paper and to create the complexity dimension.

### ***Questionnaire***

To have the practitioner in focus when developing the maturity model it was deemed important to validate the findings from the workshops with more data from practitioners. To collect the data, the online platform Qualtrics was used to create two surveys. One survey to get responses from members of the construction community, which did not have prior experience with working with strategic partnering and the other survey for respondents who were working in a strategic partnering setting. The questionnaires were developed using questions derived from the workshop “Possibilities and barriers to changing to hybrid governance” described in the previous section and sent out to representatives from the practitioner networks for feedback. The

comments, suggestions and corrections from the representatives were considered and used to create the final two questionnaires.

The first questionnaire was distributed through practitioner networks of architects, engineers and contractors in Denmark, with 36 responses of whom 60% were CEO's. The other questionnaire was sent by direct email to a building client and its two strategic partners. The response rate was 61% and 17 responses were collected, all from upper management.

Comparison of responses from the two questionnaires

In both questionnaires a number of questions were identical and it is possible to make a comparison between them to see differences and similarities.

The first of these were "What qualitative evaluation criteria does your company focus on using / being good at?", with ten possible answers provided graded on a 5 level Likert scale. Of the ten possible answers the three with the highest mean score were; collaboration, process management and common goals. This was true for both groups, and shows that these qualities which are emphasized in hybrid organizations are seemingly issues of high priority in the construction industry in general.

In the question of "A strategic partnering can create..." out of 17 possible answers in the top five of both groups were "better collaboration", "repetition of processes", "possibility for knowledge exchange" and "fewer conflicts". Both groups also found that the answers with lowest mean score to be "reduced start-up costs" and "better building operations". The largest discrepancy was found on the answer "Less waste in processes". The practitioners who did not have experience with strategic partnering had it in the top 5, whereas the practitioners with experience from strategic partnering gave it the third lowest mean score.

The third question analysed was on the effects on companies when participating in strategic partnering projects. Of the eight possibilities given both practitioners with and without experience from strategic partnering projects gave “competence development” the highest mean score and “new relationships” were in the top three in both groups questionnaire responses. Both groups saw the least impact on fewer overhead costs, being last or second to last in the two response groups. The largest discrepancy were found in “stable income/costs” where the practitioners without prior experience with strategic partnering had it in the top three as expected impact on their companies. Practitioners with experience on the other hand had it as the second last.

The fourth question asked the practitioners which challenges they as a company faced when working in a strategic partnering project. Ranked in the top two of 13 possibilities presented for both practitioners with and without prior experience in a strategic partnering project were the “vulnerability of key personnel leaving the project” and in the top four at both were “lack of building client competences”. In the bottom for both groups were “lack of artistic freedom” and the largest discrepancy was found on the challenge of “four year framework contracts are too short in relation to costs”. The practitioners without prior experience did not see this as a problem and had it as the second lowest mean score, while the practitioners with experience had it in the top three. This may be an indicator that the expected time from a strategic partnering project starts until it reaches its full potential is longer than expected, or that the start-up costs are greater than expected by the practitioners without experience.

### ***Model validation***

In order to validate the model a meeting and discussion forum was set up with practitioners, discussing relational contracting with the CSCT model as a central tool. The practitioners were

from middle and upper management in a large contractor, engineering and consulting company in the Danish construction industry. To get an independent assessment of the model the participants were not part of the model development workshops or questionnaire. The company had some but limited prior experience with relational contracts.

## The Construction Supply Chain Transaction Maturity Model

The literature and empirical data was analysed and triangulated to produce the Construction Supply Chain Transaction maturity model (CSCT). In the CSCT model the four levels of maturity, see figure 2, is described as such:

- At level 1 the allocation principle for the contract is price alone. This makes it the purest form of market based relationship and this also makes the choice of supplier completely transparent. The relationship is however adversarial and a zero sum game where the incentive is on the client side to get the lowest price and on the supplier side to fulfil the contract while expending the least amount of resources. All incentives are hard incentives based on monetary reward or punishment, and disagreements are solved by the contract or the legal system.
- At level 2 the allocation principle is price coupled with other factors. These factors can be objective or subjective like, success of prior projects, experience, CSR, sustainability or other quality factors. The interaction is still mediated by a market, but some of the zero sum game nature of the interaction is elevated by the addition of other objectives. The majority of incentives are still hard and monetary in nature and conflicts are still mediated by contracts and the legal system.
- At level 3 the allocation principle is primarily on common goals for a single project with a formalized price structure and open books. This removes many of the hard monetary

incentives and replaces them with soft collaborative and coordination structures. The focus is on creating positive outcomes for all in the project and to facilitate this a hybrid bilateral governance structure is put in place.

- At level 4 the allocation principle is on creating common goals on a portfolio of building projects and has a formalized price structure with open books. The focus is on long term gain sharing and creating development goals, which benefit all parties. A multilevel hybrid bilateral governance structure ensures that on strategic, tactical and operational levels the projects are managed to create cross project synergies and learning.

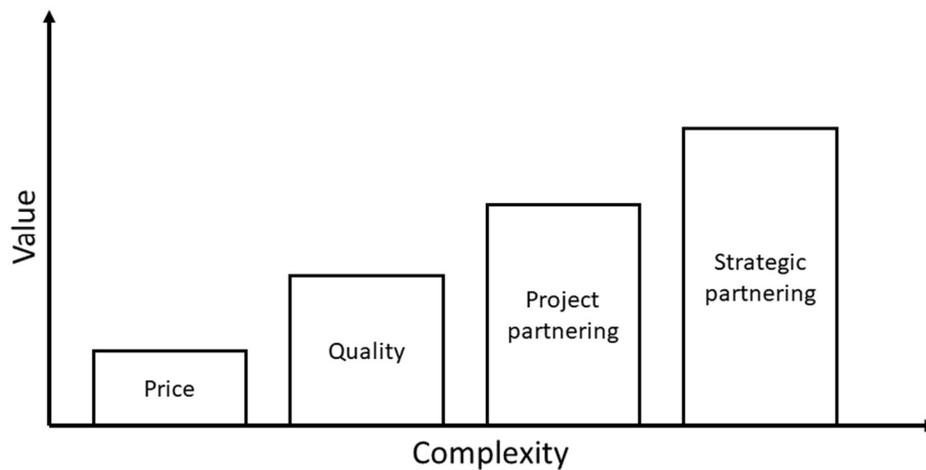


Figure 2 The Construction Supply Chain Transaction maturity levels adapted from the Supply Chain Relationship maturity model developed by Meng et al. (2011)

In a TCE analysis the CSCT model has a transition point in terms of government mode between level 2 and level 3. The two first levels where price and quality is used as supplier evaluation criteria the relationship is a market based relationship. At level 3 and level 4 the governance structure becomes bilateral or hybrid, so both client and the suppliers have joint responsibility.

In addition to the graphical representation of the CSCT maturity model, the analysis matrix part of the model creates insight into what happens to the value and complexity

dimensions as a buyer-supplier relationship is changed from one level to another. The analysis matrix can be seen in Table 4, with criteria in alphabetical order and Key Attributes (KA) describing each criteria on each level.

Table 4 The analysis matrix of the CSCT maturity model

Dimension	Criteria	Level 1	Level 2	Level 3	Level 4
Value	Collaboration	None	Low	Common decisions	Common culture
	Conflict resolution	Contract and judicial	Contract and judicial	Conflict resolution framework	Conflict resolution framework
	Cost transparency	None	None	Open books	Open books
	Development	None	Low	High on single project	High on project portfolio
	Holistic risk management	None	Low	High – short term	High – long term
	Integration of teams	None	None	Possible	Assured
	Trust	Contract	Contract and capability	Common incentives short term	Common incentives long term
Complexity	Benchmarking	The market	The market and value of criteria	Open books and value of criteria	Open books and value of development
	Building client competences	Low	Medium	High	Very high
	Communication	Contract	Contract and criteria	Joint communication	Joint communication
	Power dynamics	Simple Adversarial	Nuanced Adversarial	Collaborative with few stakeholders	Collaborative with many stakeholders
	Procurement strategy	Simple	Nuanced	Developed	Integrated
	Senior management involvement	Low	Low	Medium	High
	Transparency in award criteria	Simple	Nuanced	Qualitative	Qualitative

The value dimension

There are seven value criteria in the CSCT model described in detail in this section.

*Collaboration* in a market situation, level 1 and 2, the parties enter into a mutual monopoly situation where each party is best served by not cooperating. In a hybrid governance structure, like level three and four, decisions are made to reach common objectives and over many projects common culture will facilitate a deep collaboration between building client and AEC companies.

*Conflict resolution* can be a very time and resource intensive process, and in the construction industry conflicts are inevitable. Having a resolution process that minimizes the use of legal professionals and the court system, minimizes the costs associated with these conflicts and the time spent on them.

*Cost transparency* is the ability for parts of the value chain to be able to know cost drivers in other parts of the chain. In a market mediated transaction there is a strong incentive to keep actual cost information secret, since this information is a strong negotiation tool. Open books allow transparency and makes it possible to optimize costs across the value chain.

*Development* of new products or processes are very valuable and can reduce costs, create new capabilities or develop new market segments. Building clients and companies can gain value from moving to a higher maturity level, but will benefit them in different ways.

*Holistic risk management* is a dimension since risk management is carried out by each part in the construction value chain regardless of maturity level, but the more mature levels offers the possibility to make risk management across the value chain and projects.



*Integration of teams* across the value chain is a prerequisite to realize some of the value in a more mature procurement strategy. The integrated teams use the different perspectives of the participants to make solutions which have a higher likelihood of success.

*Trust* in the CSCT model is used to distinguish the different types of trust which are in the four levels.

Complexity dimension

The CSCT maturity model has seven complexity criteria. As the maturity of the procurement method increases a number of processes become more challenging and organizational changes makes the advancement to a more mature level a non-trivial challenge.

*Benchmarking* of cost to performance changes drastically when the procurement strategy becomes more mature. In a market contract based on price it is essentially the market that dictates the costs. Adding quality criteria adds this on top of the market price, but the nature of benchmarking completely changes when advancing to level three and four. The open books enables a true cost calculation for the companies in the value chain, but does not give any information of the market prices of the same products or services.

*Building client competences* becomes very important as the procurement strategy matures. As the maturity level increases the building client becomes very involved at every stage of the construction process, and needs to be able to give relevant input to the process.

*Communication* is a core part of any building project. As the procurement strategy matures, communication between the stakeholders in the value chain becomes more important to realize the full potential of the more mature strategy. This then requires that communication is managed, efficient and transparent.

*Power dynamics* in a market relationship it is safe to assume that there is an adversarial relationship and that all actions can be seen as self-interested in a zero sum game. When a hybrid governance structure is formed the relationship becomes more challenging.

*Procurement strategy* becomes a deeper part of the organization as the maturity increases. Market transactions based on price alone is the most simple procurement strategy to implement. Adding quality parameter to the selection process requires a more nuanced approach, while a project partnering procurement scheme requires a deep understanding of internal organizational processes and the processes of others in the value chain. A strategic partnering project requires close collaboration deep integration.

*Senior management involvement* is not necessary in market based selection with price as the only discriminator. But as the level of integration and commitment increases at level three and four, it becomes very important that the goals and objectives are aligned.

*Transparency in award criteria* is very important to maintain adequate assurance, especially for public building clients. Awards based on price is the simplest to communicate not only internally but also externally. Once qualitative parameters are included these and their influence on the award of a contract to a supplier has to be communicated and justified using an objective scoring system.

### ***Differences between CSCT and SCR***

The four levels of the SCR and the CSCT model are the same, but while the SCR model has the CMM maturity model depiction of steps (squares with arrows going to the next step) the CSCT has the potential performance perspective depiction of four pillars with value and complexity as the two axis. None of the key attributes or criteria have been used in the same way in analysis matrix of the SCR and the CSCT. In this way they are not very closely related.

The SCR model contains information which is only applicable in a UK setting, describing tender documents and frameworks which are only used in the UK. The CSCT model is agnostic when it comes to which regulatory or contract framework is used and as such does not contain this type of information.

As can be seen from table 1 when doing an analysis using the SCR model's main criteria and sub-criteria, only the positive aspects of an increased maturity are considered. This makes the analysis a forgone conclusion as to which level should be used; the most mature. The CSCT model is an answer to this in that both negative and positive aspects are considered.

Both CSCT and SCR use Key Attribute's to describe the criteria at the four different levels. An active effort was made to make these as simple and distinct as possible, and if there was not found to be a significant change in a criteria from one maturity level to the next, no such difference was made in the CSCT model.

## CSCT model validation

As part of the feedback on the model from the discussion forum there was a general consensus that the model gave an interesting perspective on procurement and it sparked conversation and reflection. One remark was that the order of the complexity dimension could be altered in order to reflect importance. It was in their view that "Senior management involvement" should be at the top since this was seen as critically important to the success of relational contracts. They also remarked on the "Cost transparency" criteria being in the value dimension as being procurement side centred. For a company in their position any openness about prices, client lists or processes was seen as a potential hazard for the company and could be exploited by competitors.

Upon reflecting on the feedback two areas of further research was identified. The first is the development of a CSCT model which has the supplier side as its focus. The second is to determine which criteria is most important for success and rank the criteria in the model.

## Practical implementation

From the beginning of the development of the CSCT maturity model practitioners have been at the centre to understand what challenges and potential value practitioners seek when using a more mature procurement strategy. This is why the model is focused on using sparse data and as few criteria as possible, while still giving a realistic picture of the circumstances at each level of maturity. Using the model in an organization procuring building services can happen both at the tactical and strategic level, and if higher levels of maturity is relevant the model shows that there has to be a strategic component. This means that the model supports analysis of ongoing and future projects, and it can support a dialog in an organization where a maturity perspective on their procurement schemes is seen as relevant.

The model can also be used as an academic tool and has a deep and deliberate theoretical grounding in Transaction Cost Economics. As such the CSCT model can be seen as a deliberate attempt to take the general TC perspective and making an industry specific instance, where the industry specific boundary conditions of construction are taken into consideration. While such a model can be made for many different industries, and will likely contain some of the same levels and criteria, the CSCT model is singularly focused on the construction industry.

The model has the potential to be used in the entire supply chain, but it has a buyer's perspective at its core. In this way it can be applied by any organization that procures building services.

## Discussion

The CSCT maturity model covers a range of the different buyer-supplier relationships found in the construction industry. It does however have notable exceptions like framework agreements, Public Private Partnerships (PPP) and vertical integration.

As a concept, PPP means a great many things in different countries (Koch and Jensen 2009). In some countries it is a way to raise private capital for public infrastructure projects and in others it is a way to develop novel solutions where the companies' profits are contingent on the solution working as intended. As a procurement strategy, it is also not applicable to private building clients or companies, and in this way not generalizable to the entire construction industry or value chain.

While in a TCE sense the vertical integrated governance structure, the hierarchy, is fully valid, it is not included in the CSCT model. For one it is not seen very much in a construction context outside large contracting firms that act as land developers for industrial buildings. It requires all steps of the building process including ownership and operation to be conducted within the same company. The possible use cases for such vertical integration seems to be few and require a different type of analysis, which cannot be provided with the CSCT model.

When making a thorough analysis it is possible to see that the SCR model, which the CSCT model is based on, implicitly takes a building client view. As such the CSCT model has a dyadic perspective on the supply chain, only looking at the procurement considerations from one entity procuring building services with a single interface. The creators of the SCR model have however not explicitly stated this. An example of this is the "Cost transparency" criteria. If the model was supplier centric "Cost transparency" would be in the complexity dimension. The reason is that enabling the building client to see the exact cost structure of your company is not

only a technical challenge, but can also be viewed as making the company vulnerable to exploitation. Having open books requires trust that the building client and others with access do not use this knowledge in a way that is detrimental to the company. If for instance open books are used to negotiate prices lower, instead of using a fixed predetermined price structure, this hurts the company's position.

The CSCT model has some of the same limitations as the SCR model in terms of where it can be applied. Both models use practitioners from EU countries as data sources and this limits the assured applicability of the model to EU markets and markets with similar construction procurement traditions and rules. Relational contracts have however been used in Asia, Australia and the Americas and as such the model may, possibly with small modifications, be valid in these markets. This is an area which needs further study.

In terms of other relational contract types or hybrid governance modes that have been identified in literature, such as Integrated Project Delivery or Alliancing, the CSCT model may have limited use. It has been deemed outside the scope of this paper to discuss these procurement options but they would in all likelihood be at level 3 or level 4 in the CSCT model. Hybrid governance modes in construction and their taxonomy, describing how they relate to each other, is a field of further research.

## Conclusion

This paper answers the stated research question by developing the Construction Supply Chain Transaction maturity model (CSCT), which take into account both the value and complexity of using mature procurement strategies.

One type of procurement strategy is not suitable for all transactions and this is why the CSCT has been developed. The CSCT maturity model is a parsimonious potential performance

maturity model developed to support procurement strategy analysis in the construction sector by practitioners and academics. In the model four maturity levels are used; price, quality, project partnering and strategic partnering. To evaluate which maturity level is appropriate for a given transaction, seven value criteria and seven complexity criteria have been identified to show which change comes with increasing procurements strategy maturity. The organization needs to handle a higher level of complexity in order to get the potential value, and some types of transactions do not benefit from an increase in maturity.

Finding the right balance between value and complexity ensures the highest probability of a positive outcome for a construction project.

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## Disclosure statement

There are no conflict of interest related to the research presented in this paper.

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## Data availability statement

The data gathered in the workshops are of a sensitive nature and can only be obtained by contacting the corresponding author with subsequent written consent of the participants. The data from the questionnaire can be obtained in anonymized form by contacting the corresponding author.

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## APPENDIX C

Paper - Berg et al. 2021

*Reconfiguring the construction value chain: Analysing key sources of friction in the business model archetypes of AEC companies in strategic partnerships*

## **Reconfiguring the construction value chain: Analysing key sources of friction in the business model archetypes of AEC companies in strategic partnerships**

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## **Reconfiguring the construction value chain: Analysing key sources of friction in the business model archetypes of AEC companies in strategic partnerships**

Lack of innovation and productivity in the construction industry compared to other industries is often explained by the institutionalized roles and fragmented nature of the construction value chain. Closer connections and collaboration (such as strategic partnerships) among architecture, engineering and construction (AEC) companies and across the values chain is often prescribed as a strategy to improve the performance of the construction industry. However, the institutional roles of AEC companies and their archetypical business models serve as important reference points for the sector. How these business models interact, and the friction created when they come in close contact is not well researched and understood. This paper identifies business models archetypes for architect, engineer, contractor and materials supplier based on workshops and interviews with practitioners. Friction is identified in and between the business models of AEC companies engaging in strategic partnerships. The analysis shows that architect archetypes face friction with regard to their profit formula and could benefit from profit sharing. The engineering archetypes face friction in their processes since they have to coordinate with specialists from other companies. Contractor and supplier archetypes face friction in their profit formula since the open books force them to alter business practices.

Keywords: business model; friction; archetypes; architecture, engineering and construction sector; AEC; value chain;

### **Introduction**

One of the key criticisms levied against the construction industry is the fragmented nature of the architecture, engineering, and construction (AEC) value chain (Gottlieb et al., 2020, Staykova & Underwood, 2017, Fellows & Liu, 2012). This has prompted proposals to make the industry more efficient by reducing this fragmentation and have



closer collaboration, e.g. in strategic partnerships (Costa & Tavares, 2012, Lahdenperä, 2012a Frederiksen et al., 2019). From an economic, business and risk perspective this is an optimal solution, however the fragmentation persists. Whenever an economic system does not default to the most optimal configuration it is often due to friction. In the AEC industry one of the key sources of friction come from the institutionalized roles and their business models.

The AEC sector's low productivity and systemic challenges have been the subject of political scrutiny (e.g. Egan, 1998 and Nielsen *et al.* 2010) and research for decades (Gadde & Dubois, 2010, Bygballe et al., 2010, Badi & Murtagh, 2019). Part of the challenges can be traced back to the fragmented nature of the value chain organized around well-rehearsed institutional roles. The AEC sector is a classic case of project-based organisations (Chinowsky, 2011), working in dynamic environments and collaboration patterns that favour short-term goals. Eriksson (2013) argued that due to the project-based nature of the sector, project teams tend to focus on short-term results and move on to the next project without the opportunity for reflection, thus resulting in discontinuities in the knowledge flows and learning. After construction projects are terminated project teams usually dissolve (Bower, 2003) and therefore the transfer of the valuable experience gained during the project execution is limited. Consequently, the learning in the industry is more organised around playing certain archetypical roles rather than specializing within a certain market (Thomassen, 2004). These roles constitute important reference points in the AEC industry, where few processes are standardised and few projects are repeated (Hall et al., 2020, Katila et al., 2018). To be a part of the construction value chain companies find themselves organized in similar ways according to the institutionalized role. They offer similar value propositions, use the same type of resources organised in the similar processes and rely on the same way

of creating profit. In other words, each institutionalized role should exhibit a similar business model.

To overcome the systemic challenges, calls have been made to reconfigure the supply chain changing the ways companies do business. Under agendas like Digitalization, Industry 4.0 and relational contracting, initiatives promise to transform the businesses and subsequently the industry. A specific example of relational contracting practices in the AEC industry is Strategic Partnering/Partnerships (Eriksson, 2010), Integrated Project Delivery (Lahdenperä, 2012), and Alliancing (Laan et al., 2011). Changes like these have implications for the configuration and coordination of the underlying business models. The close proximity e.g. making a joint venture, may force changes in business model or several business models may be mismatched and have conflicting goals. When a company changes its business model or there is a mismatch between business models this is associated with friction (Williamson, 1989, Johnson et al., 2008). There is thus a need to analyse how changing business models create frictions across the value chain and within a company.

Research on the business models of AEC companies have tended to focus on only one part of the value chain. Previous research on coordinating business models in the AEC sector, has an emphasis on searching for integrated models that span the entire construction value chain (Brady *et al.* 2005, Brege et al., 2014). However little research exists on how close collaboration in the value chain transforms business models connected to the institutionalised roles and general organisation of the AEC industry. This leads to the research questions posed in this paper:

*What are the points of friction in and between business model archetypes when they are subject to transformation in the value chain in the form of strategic partnerships?*

### ***Practical research context and paper structure***

The study has been conducted in Denmark, where there has recently been a strong interest among public building clients to establish strategic partnerships with delivery teams consisting of consortia of private companies. A strategic partnership is a long-term collaboration covering a portfolio of building projects, which are developed and executed in close collaboration between the building client and the companies in the delivery team based on mutual trust (Gottlieb et al., 2020). The study was related to a large R&D initiative concerning sustainable building renovation in a societal partnership called REnovating BUildings Sustainably (REBUS) with participants from the whole construction value chain in the Danish AEC sector representing the institutional roles such as building clients, architects, consulting engineers, contractors, material suppliers and knowledge institutions.

Strategic partnership is a relational contracting scheme, which is fairly new in the Danish construction industry. In a strategic partnership several companies in the construction value chain come together to create a joint venture to tender a bid on a framework agreement. The building client then evaluates the tenders based on MEAT (Most Economically Advantageous Tender) criteria, with a heavy emphasis on collaboration and understanding both between the companies in the joint venture and their understanding of the building client's needs, vision and goals (Gottlieb et al., 2020). This type of contract is in close relation to strategic partnering which was first described in the 1990'ies (Latham, 1994, Egan, 1998). The strategic partnership sees the joint venture bid on a four-year framework contract created by a single building client organization. The delivery team in the joint venture consists of a least an architect company, an engineering consulting company and a contractor, but often also a consultant acting as facilitator of collaboration in the team and possibly material

supplier and other specialized companies. The use of conflict mitigation, open books and collaboration are some of the hallmarks of a strategic partnership and the first in the Danish construction industry was seen in 2016 (Frederiksen & Gottlieb, 2019). Similar relational contracts have been used in the UK and Sweden (Kadefors, Thomassen, & Jørgensen, 2013).

The paper opens with a theoretical framing in order to establish two key concepts; business models and friction. The current state of business model research of the AEC industry is also elucidated. Subsequently the methodology presents the details of the empirical data gathering efforts from workshops and interviews. The empirical data is then used to develop business model archetypes for the institutionalized roles in the AEC industry; architect, engineer, contractor and supplier. Using workshop participant interviews the business model archetypes are validated and the archetypes are compared to AEC business models in literature. The archetypes and practitioner interviews are used to evaluate friction in and between these business models in the implementation of strategic partnerships. The paper is concluded by a discussion connecting the findings to the broader development of the AEC industry, AEC business model research and finally a conclusion.

### **Theoretical framing**

This section outlines the theoretical framing of the paper on business models and friction. The business model section is split into two parts; defining the term business model and an overview of AEC business model research.

#### ***Business models: Understanding how companies work***

A business model is a model of how a business operate to create value. As with other scientific models, a business model seeks to make a simplified description of a

phenomenon, in this case a business, to enable description and analysis. As such the business model does not describe the myriad of social, organizational or economic interactions which the company consists of; it describes the logic behind these interactions (Richardson, 2008).

There are in the literature many definitions of business models. Fiel (2013) analysed many such definitions and concluded:

“We define a business model as a representation of the value logic of an organization in terms of how it creates value and captures customer value” (Fiel, 2013, page 85).

A value proposition is the central dimension of a business model. Teece (2010) claims that a business model is more generic than a business strategy. However, it is necessary to couple strategy and business model analysis to protect competitive advantage resulting from new business model design.

The use of business models as an academic tool has its roots at the turn of the millennium (Richardson, 2008). At its core a business model is a conceptual model which simplifies the day-to-day operation of a company into pre-defined dimensions of the business model framework. An example of a widely used business model framework, that has also been used to analyse the AEC industry, is the Business Model Canvas (BMC) developed by Osterwalder (2004). The BMC has nine dimensions: Value Propositions, Customer Segments, Customer Relationships, Channels, Revenue Streams, Cost Structure, Key Resources, Key Partners and Key Activities. The dimensions serve to simplify the description of the business and at the same time limit the business model framework, since it cannot describe behaviour outside the predefined dimensions.

The scientific community has developed business models as a scientific tool, and developed business model frameworks suitable for scientific analysis (Amit & Zott 2001, Osterwalder 2004, Sommer 2012, Christensen et al., 2016). Each framework is focused on different aspects of a business and as such the business model developed using the four dimensions of Amit & Zott (2001) (Efficiency, Complementarities, Lock-in and Novelty) will be substantially different compared to a business model made using the nine dimensions of the BMC. As with other scientific research it is important to use an appropriate framework and thus in the following section business model frameworks used in AEC business model research is detailed.

### ***Business models in the AEC industry***

The study has used a broad literature review on business models covering both scientific papers and industry reports and 14 AEC business model studies were identified as seen in table 1. Of the 14 business models, seven were developed with a bespoke business model frameworks. Of the seven remaining four used BMC and the remaining three business model frameworks used were developed by Teece (2010), Sommer (2012) and Amit & Zott (2001).

*Table 1 Business model types and analysis on construction companies from literature.*

Business model	Scope	Analysis	Reference
framework			
Green Business models	Multinational enterprises (MNEs)	Barriers	(Hart et al., 2019)
Business Model Canvas (modified)	Business network	Business model change	(Mokhlesian & Holmén, 2012)
Bespoke Business model framework NICE	Zero Carbon Buildings Developer, Contractor, FM Service provider	Business model innovation Value drivers and value appropriation	(Zhao et al., 2016) (Rajakallio et al., 2017)
Bespoke Business model framework	International construction companies	Firm performance	(Jang et al., 2019)
Bespoke Business model framework	Consultancy	Business model reconditions	(Ling & Li, 2016)
Bespoke Business model framework	Manufacturer of prefabricated buildings	Development of business model framework	(Brege et al., 2014) (Lessing & Brege, 2018)
Business Model Canvas (modified)	Manufacturer of building materials	Description of business model	(Nußholz, Nygaard Rasmussen, & Milios, 2019)
Teece Business model framework	Building client and AEC companies	Sustainable renovation	(Jonsson et al., 2017)
Business model Canvas	Building client and AEC companies	Energy efficiency Conservation Retrofit	(Dunphy et al., 2016)
Business model Canvas	Sub-contractor	Ecosystem business model	(Laine et al, 2017)
Bespoke Business model framework	Architect	Business models for architectural service delivery	(Bos-De Vos et al., 2016)
Bespoke Business model framework	Building client and AEC companies	Sustainable Innovation	(Romero et al., 2016)
Bespoke Business model framework	Zero Carbon Buildings	Typology of business model innovations	(Zhao et al., 2018)

When looking at existing research in business model in construction a few trends can be discerned. Firstly, when research is done on AEC business models there is a tendency to develop bespoke business model frameworks, see

Table 1. This bespoke approach is however problematic since this makes it difficult to assess the conclusions made using these bespoke frameworks, and makes it very difficult to compare business models. Existing research on business models in the AEC sector has also only looked at a single company type or variations of business models within a single segment (Pekuri et al., 2013, Jang et al., 2019, Laine et al., 2017, Höök et al., 2015, Abuzeinab et al., 2017, Bos-de Vos et al., 2016). The focus on a single segment of the AEC value chain misses the complexity of business models interaction across the construction value chain.

The business model framework is also important when interacting with practitioners who can have varying levels of knowledge of business model terminology. In a study about business models in the Finnish construction industry Pekuri et al. (2013) concluded:

“The interviewees had significant problems describing their companies’ business models and value creation logic, pointing out the lack of analysis and understanding of customer values and needs in the project delivery process.”

Studying the business models of architecture firms Bos-De Vos (2017) noted:

“... participants, for example, often seem not aware of what a revenue model exactly is or what different types of revenue models can be used.”

When choosing a business model framework, it should therefore be of suitable complexity for the practitioners to give valid responses. In choosing an appropriate business model framework it can function as a sense-making tool for the practitioners (Weick, 1995 p. 412, Holzer, 2009).



Looking at the existing AEC business model literature there is a research gap in describing the existing business models in the AEC sector using established business model frameworks. It also highlights the lack of research making cross value chain assessments of business models when working with business model innovation and business model transformation that involve a large part of the AEC value chain.

### ***Friction: Understanding changing business models***

The traditional description of what today is thought of as economic friction was physical in nature, e.g. the distance a good has to travel to make an exchange (Aristotle [350 BCE] B. Jowett, 1999). In modern economics most forms of friction are related to information in one form or another (Hardt, 2009). When it comes to the friction associated with the interaction of companies, Transaction Cost Economics (TCE) has been dominant in the last decades. Oliver E. Williamson, who received his Nobel Prize for creating TCE, has described TCE's relationship with friction this way:

“In mechanical systems we look for frictions: do the gears mesh, are the parts lubricated, is there needless slippage or other loss of energy? The economic counterpart of friction is transaction cost: for that subset of transactions where it is important to elicit cooperation, do the parties to the exchange operate harmoniously, or are there frequent misunderstandings and conflicts that lead to delays, breakdowns, and other malfunctions?” (Williamson, 1989, page 142)

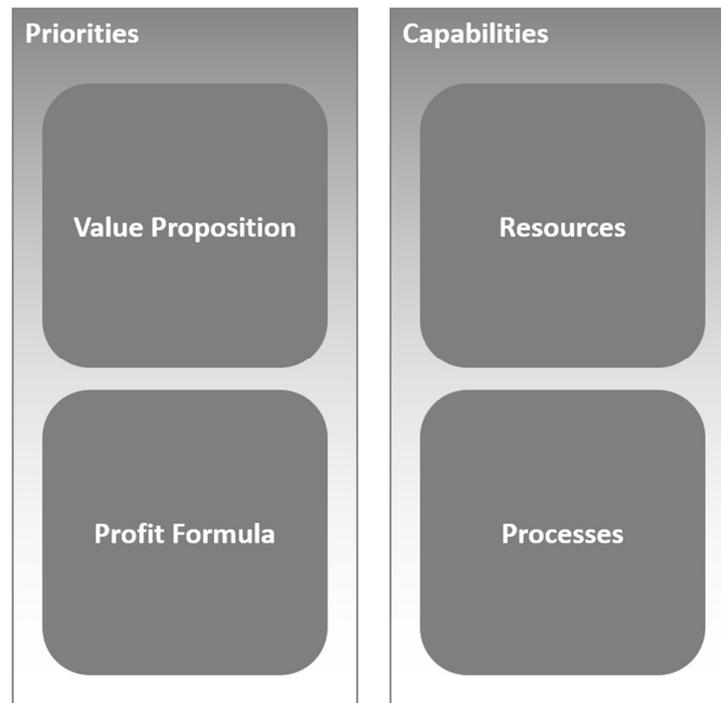
When it comes to analysing business model change inside companies, this change is also associated with friction. When a business model changes internal conflict over resources can make it hard for a company to effectively change (Kim & Min, 2015).

“...previous studies have assumed away the performance implications of conflicting assets by taking for granted that a new and superior technology replaces incumbent firms’ old technology with little friction. Yet, this implicit assumption misses the important quandary an incumbent faces when attempting to manage its old business model and new business model simultaneously” (Kim & Min, 2015, page 35)

From an analysis of the dimensions in of AEC business models and the potential for friction it is possible to make a number of recommendations when integrating the construction value chain, e.g. in strategic partnerships.

## **Methodology**

In this study an abductive approach has been used (Awuzie & McDermott, 2017, Tavory & Timmermans, 2014). The empirical research included four workshops and interviews with four interviewees. Three of the workshops were exploratory and helped to establish an appropriate business model framework. From the literature review the BMC framework was identified as the most used business model framework in AEC business model research. In the three exploratory workshops we used several forms and subsets of BMC to see how best to have a discussion with practitioners. The goal was to find a business model framework to describe the business models in the AEC sector and facilitate dialogue. For the fourth workshop we used the Four Block Business Model (FBBM) framework developed by Christensen et al., (2016), see Figure 1, and this facilitated dialogue and could be used by the practitioners.



*Figure 1 A simplified version of the FBBM framework (Christensen et al., 2016)*

The FBBM framework has two main categories, Priorities and Capabilities each with two dimensions; Value Proposition, Profit formula, Resources and Processes. Attributes of the business are sorted into the dimensions to create the business model.

The business model archetypes were identified by the researchers using data gathered from workshop number four with practitioners representing the whole value chain of the AEC sector. The data from the fourth workshop was triangulated using the data obtained in the three exploratory workshops. To validate the archetypes participants in the fourth workshop representing the different company types were interviewed and asked to comment on the archetypes. To connect the archetypes to existing AEC business model literature, each archetype was compared to AEC business models identified in the literature.

The AEC business model archetypes were then used by the authors to analyse the friction, when these are brought together in a strategic partnerships. The analysis

was augmented by interviews with practitioners. The research workflow can be seen in Figure 2.

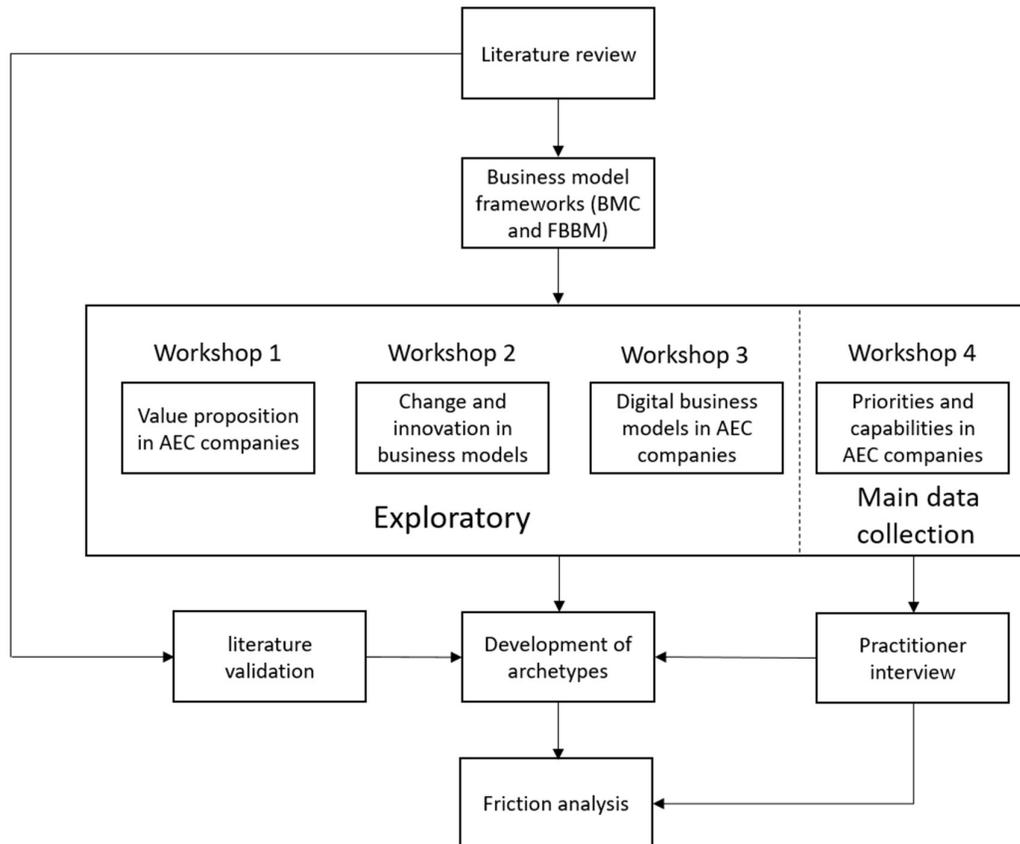


Figure 2 Research flow of the study

### ***Workshops on business models***

The participants were representatives from companies in the REBUS societal partnership and represented the whole value chain in the Danish AEC sector, including two building clients, an architect, a consulting engineer, a contractor, a material supplier and university researchers. The first exploratory workshop, see figure 2, was about identifying the value proposition of the individual companies. In the second exploratory workshop, we sought to get the participants to make a cohesive business model for a part of the AEC value chain with a focus on innovation. The third exploratory workshop

was focused on digital business models, how to understand them and how to translate them into a company in the AEC value chain. Based on the experiences we had at the previous three workshops, the full nine-dimensional BMC was replaced by the simpler and intuitive FBBM framework, which the participants could interact with, with less instruction.

### ***Workshop structure and analysis***

In all four workshops, the general structure was the same. They started with an introduction of the framework for the workshop; BMC framework with Value Proposition Canvas, a subdivided BMC framework or the FBBM framework. The participants were asked to use the framework, supported by facilitators. The frameworks were printed on A3 paper and post-it notes were supplied to write input for the framework. Depending on the number of participants, the inputs were generated by the participants individually or in groups. After approximately two thirds of the time had been used on the first two parts of the workshop, the third and final part was presentation and evaluation of the input. All participants were asked to present their work, and this was then commented on by the rest of the participants. At this stage post-its were added, cumulated or removed according to the participants input.

After conclusion of the workshop, all the A3 frameworks with post-its were collected and photographed by the facilitators of the workshop. This became the primary data collection together with researcher notes to document the discussions during the input and discussion phase of the workshop. In Table 2 general information about the workshops can be seen.

*Table 2 General information about the four workshops used for data collection.*

Workshop no.	Date	Duration	Participants	Type
1	23-05-2017	2 hours	10	Exploratory
2	16-04-2018	3 hours	12	Exploratory
3	07-05-2018	3 hours	7	Exploratory
4	26-11-2018	2 hours	10	Main data gathering

### ***Development of the business model archetypes***

In the fourth workshop data was collected to develop of the business model archetypes.

As an example, the data for the architect archetype can be seen in table 3.

Table 3 Data from workshop and the corresponding archetype

	Data from workshop	Architect archetype	
Priorities	Economy, Art, To be/become famous (reputation), high architectonic quality, win architect competitions, Get projects, participate in competitions, prestige/reputation, make prestigious buildings, Create the framework and inspire the client	<ul style="list-style-type: none"> <li>• High architectural quality</li> <li>• Art</li> <li>• Prestige (reputation)</li> <li>• Development</li> <li>• Advise the client</li> <li>• Listen to the users</li> </ul>	Value propositions
In between	Presentation of proposals	<ul style="list-style-type: none"> <li>• Selling hours to cover high variable costs</li> </ul>	Profit formula
Capabilities	Transform idea/need into design, create the foundation for the building project, collect input and wishes from the users, "sell the building", Creative and competent employees, skill full employees – architects – projects, make esthetics and functionality coexist, put together the right teams, develop cities (create diversity), Strong BIM tools, create drawings that reflect real needs, create esthetically pleasing buildings, construction management, represent overall cohesion – in case of a plan for the area, translate vision into practice,	<ul style="list-style-type: none"> <li>• Creative and competent employees</li> <li>• Strong digital tools</li> <li>• Communication resources</li> <li>• Commercial relations</li> <li>• Project management and control</li> </ul>	Resources
		<ul style="list-style-type: none"> <li>• Integrate aesthetics and function</li> <li>• Set the right teams</li> <li>• Convert ideas / needs into design</li> <li>• Create a basis for construction,</li> <li>• Win competitions</li> <li>• Continuous development</li> </ul>	Processes

To get from the data collection in the workshops, which were made on post-it notes, all the notes were transcribed. Subsequently they were translated and grouped in to the FBBM framework. All of the attributes were then triangulated with other data from the exploratory workshops to make sure that the statements were consistent and coordinated. Statements or descriptions that could not be triangulated were discarded.

### ***Practitioner and literature validation of the archetypes***

After gathering data from the workshops, it was important to make sure that the analysis and synthesis of the business model archetypes developed from the workshop data represented a reality that the participants could recognize. Therefore, subsequent interviews were conducted with participants from the fourth workshop representing the four archetypes.

The interviews were conducted as semi-structured elite research interviews as defined by Kvale & Brinkmann (2014). Due to the semi-structured nature of the interview, a theme for the interview had been agreed, before the interview was scheduled, and the researcher had prepared a number of questions. These were grouped into introduction questions serving to create meta-data on the interviewee; Name, position, company name, educational background and experience in the construction industry. The interview then continued with three sub-sections under the main theme of business models. First, the use of business models and other similar frameworks was explored, and the interviewee was asked if he/she has experience in making such and how/if they impacted their daily work. The second sub-section focused on how strategic partnerships would impact the company business model and the potential for creating new business models. Finally, the third and last sub-section was a direct conversation about the business model archetypes developed from the workshops, and if they could recognize their own company in the relevant business model archetype. In table 4 the general information about the interviews can be seen. The interviews were conducted and transcribed in Danish and selected citations were translated to English.



*Table 4 General information about the interviews used for archetype validation.*

Interview no.	Date	Duration	Education/field
1	18-06-2019	59 min. 48 sec.	Contractor
2	18-06-2019	1 hour 30 min.	Supplier
3	19-06-2019	1 hour 6 min.	Engineer Architect

The interviews together with comparing business models from AEC companies from literature served to validate the findings (Saunders et al., 2008, Eisenhardt, 1989). This is an established method for developing business models (Lessing & Brege, 2018).

### ***Identification of friction***

To identify sources of friction the archetypes were used together with data from the interviews. The participants were asked to describe which changes participating in a strategic partnership would create for their company. The responses from the practitioners were then used together with the frictions identified using the archetypes to make the final friction analysis.

### **Description and validation of the Business model archetypes**

Through the workshops, interviews and analysis, we identified four business model archetypes, which utilise three distinct profit formulas illustrated in Table 3. Each business model is sustained through unique capabilities in the form of resources and processes, which support a specific value proposition for each archetype.

Table 3 The four archetypical business models of AEC companies and building material supplier.

	<b>Architect</b>	<b>Engineer</b>	<b>Contractor</b>	<b>Supplier</b>
Value propositions	<ul style="list-style-type: none"> <li>• High architectural quality</li> <li>• Art</li> <li>• Prestige (reputation)</li> <li>• Development</li> <li>• Advise the client</li> <li>• Listen to the users</li> </ul>	<ul style="list-style-type: none"> <li>• Advise the client</li> <li>• Prestige (reputation)</li> <li>• Ensure the building's durability</li> <li>• Innovative solutions</li> <li>• Trustworthy solutions</li> </ul>	<ul style="list-style-type: none"> <li>• Convert project material to buildings -&gt; buildability</li> <li>• Give the client what is economical possible in the project</li> </ul>	<ul style="list-style-type: none"> <li>• Products with few flaws and complaints</li> <li>• Sustainability &amp; Comfort</li> <li>• Materials are delivered on time</li> </ul>
Profit formula	<ul style="list-style-type: none"> <li>• Selling hours to cover high variable costs</li> </ul>	<ul style="list-style-type: none"> <li>• Selling hours to cover high variable costs</li> </ul>	<ul style="list-style-type: none"> <li>• Ensure constant cash flow to cover variable costs and contractual risks</li> </ul>	<ul style="list-style-type: none"> <li>• Sales of products and systems</li> </ul>
Resources	<ul style="list-style-type: none"> <li>• Creative and competent employees</li> <li>• Strong digital tools</li> <li>• Communication resources</li> <li>• Commercial relations</li> <li>• Project management and control</li> </ul>	<ul style="list-style-type: none"> <li>• Strong professional skills especially on technology</li> <li>• Strong digital tools</li> <li>• Commercial relations and project alliances</li> <li>• Project management and control</li> </ul>	<ul style="list-style-type: none"> <li>• Construction skills specially trained employees</li> <li>• Special equipment</li> <li>• Purchasing Competencies</li> <li>• Project and construction management</li> </ul>	<ul style="list-style-type: none"> <li>• Production facilities</li> <li>• Manufacturing expertise</li> <li>• Good relationship with customers / contractors</li> </ul>
Processes	<ul style="list-style-type: none"> <li>• Integrate aesthetics and function</li> <li>• Set the right teams</li> <li>• Convert ideas / needs into design</li> <li>• Create a basis for construction,</li> <li>• Win competitions</li> <li>• Continuous development</li> </ul>	<ul style="list-style-type: none"> <li>• In-depth technical studies</li> <li>• Keep the balance between unique and standard</li> <li>• Make "good enough" solutions</li> <li>• Quality assurance / review</li> <li>• Secure realizable solutions (buildability, architecture, price)</li> </ul>	<ul style="list-style-type: none"> <li>• Calculate expenses</li> <li>• Read the market (expenses, capacity, etc.)</li> <li>• Adhere to schedule and flexibility</li> <li>• Manage purchasing and logistics</li> </ul>	<ul style="list-style-type: none"> <li>• Understand the market on the short and long term (10, 20, 30 years)</li> <li>• Develop new products / new markets</li> <li>• Optimize production</li> <li>• Advertise products</li> </ul>

### ***The Architects and Engineers***

The professional consulting service providers, like architects and engineering businesses, build on a profit formula concentrating on selling hours to cover high variable costs. It is important to note that the way to classify costs can depend on the boundary conditions that a company has in a given market. Since professional consulting service providers are knowledge firms, the fixed cost (e.g. office space leases, insurance and office equipment) is negligible when compared to the variable cost of wages to highly skilled specialists. Both architect and engineering businesses have a strong focus on advising the clients as a central part of their value proposition by using e.g. references to previous projects. However, their underlying capabilities differ, and while a typical architect's competences concentrate on integrating aesthetics and functionality, a typical engineer focus on in-depth technical studies and quality assurance. Architects and engineers share a strong emphasis on digital tools and the ability to win competitions. They primarily differ with regards to competencies and, to some extent, the scale of projects. Participation in competitions and bidding processes represent a significant upfront cost, which every competing company must recuperate through overhead on other projects. Consequently, many professional service providers prefer making framework agreements with building clients to avoid the extra cost and risk of competitions. This requires competences in managing long-term relationships with building clients and creating the trust necessary for the building client to be willing to commit to such an agreement.

### *Practitioner validation*

In the interview with practitioners from an engineer company the response to the process point of, “Make ‘good enough’ solutions” (see table 5), was that this term would be framed differently in the organization.

[Interviewee 1] ”Officially we wouldn’t say that we make “Good enough” solutions.”

[Interviewee 2] “Good enough solutions, yes. I do understand what it is you are saying because we would not put it like that.”

They were more comfortable talking about economic constraints and proven methods, instead of solutions as “good enough”. It was agreed that this ability to make solutions, which are fit for purpose and not over engineered, or needlessly complicated or bespoke, is very important when it comes to making a building process run smoothly. In the same interview the architect commented that a similar principle could be applied to the architect’s business model. In some cases, architects will purposefully reduce the number of new elements in a project to reduce the risk of several solutions not working, or having adverse interactions between several novel elements. It is important for an architect to be able to decide where it is important to innovate and where it is important to stick to a proven technology, method or design.

### *Literature validation*

As found in the literature review, prior research has been done on the business models of architects. Research by Bos-De Vos et al. (2016) about the business model of architects use a bespoke three dimension business model framework. The first is *Value Proposition* and shows similarities with the archetype in terms of architects having “Development” as part of their business model. Bos-De Vos et al. (2016) differentiates

between “Product development” and “Business case development”. The architect both listens to the client and offers advice as part of the value proposition. An architect strives to have close contact to the client in order to keep a central role in the construction project.

The second dimension is *Resources* where “Commercial relations” with developers or contractors are considered essential to an architect. They also have low fixed costs and do not in general own land or physical assets.

The third and final dimension is *Value Capture*. It is highlighted that strong “Project management and control” capabilities are essential to capture value. Negotiation of fee from developers or other partners was seen as problematic and that not all architecture firms had a focus on monetary compensation.

Due to the significant differences in the underlying frameworks of the archetype and the Bos-De Vos et al. (2016) it is not possible to say if the discrepancies between the two are due to the frameworks or actual differences. The similarities are nevertheless present in all of the dimensions and more than half of the elements in the Value Proposition of the architect archetype are found in the Bos-De Vos et al. (2016) paper.

Regarding construction consultancy research from Ling & Li (2016) show that “Innovative solutions” and “Project management and control” should be a core focus. High quality and “Trustworthy solutions” are essential to create competitive differentiation. Since the paper has a clear target in terms of the Chinese market and do not differentiate engineering firms from other construction consultancy firms it is not possible to make a very close examination and comparison to the archetypes.

### ***The Contractor***

The profit formula of general contractors builds on a sustained cash-flow model to cover high variable costs and contractual risks. Sustained cash flow is needed to cover the often-long span of time between an expense being paid by the contractor and the building client reimbursing the contractor. The high variable cost of contractors comes from wages to employees (in-house production) as well as from building materials, hiring equipment and sub-contractors. The sustained cash flow is achieved by carefully following the market and shaping projects in a way that fits the capabilities and capacity of the company. Depending on the contractor, some of the turnover is secured through tendering processes - but in all cases the ability to document the capabilities and capacities is important e.g. through references.

The key value proposition of the contractor is to convert project drawings and other specifications to physical buildings, delivering the project within the economical boundaries of the project. This requires contractors to be capable of ensuring buildability of design, calculating for realistic estimates on costs and time, managing purchase and sub-contractors, assessing and handling risk through the project life cycle, monitoring and controlling project progress and handling the various stakeholders in and around the project. The capabilities of the contractor first and foremost consist of human resources and include technical construction skills and project management competences.

### ***Practitioner validation***

The very experienced contractor who was interviewed did find that the archetype in the form it was presented was comprehensible, and wished for further development as to what changed in the archetypes under new market forces or when new collaboration

schemes were introduced. A point of clarification, which was made and could expand the value proposition of the contractor in the model, is explained by the following quote:

“If you want to show what the turn-key contractor can do for the client, which none of the others [in the supply chain] can do, it is to guarantee the client a fixed price early in the design phase.”

This value proposition that essentially removes a big part of the risk of construction from the construction client and transfers it to the contractor, is a value proposition which is valid for a segment of the market where the tolerance of budget risk is low.

#### *Literature validation*

Business models have been developed for contractors and published in the academic literature. In these there are a number of similarities to the business model archetype of a contractor. In Rajakallio et al., (2017) the researchers use the Amit & Zott (2001) business model framework modified with a fifth dimension; Novelty, Efficiency, Complementarity, Lock-in and adding the dimension Risk. In the Novelty dimension the element “...optimising buildability of solutions” is very close to the Value Proposition of the construction client archetype “Convert project material to buildings - > buildability”. In the dimension Complementarity the element “Creating value for the client (developer) through solutions that lower investment costs” mirror the Value proposition of the contractor archetype “Give the client what is economical possible in the project”.

Since the Rajakallio et al., (2017) business model description is of contractors who are using Design & Build (DB) contracts there are specific attributes to this type of

contractor which is not in the archetype. The Risk dimension has an attribute of “Creating value for the client (developer) through lowering developer’s risk position” which is typical of a DB or a turnkey contractor. This is not in the archetype since this value proposition while valid is not true for contractors in general.

### ***The Supplier***

The profit formula of material suppliers is based on selling products and systems. Typically, they strive to optimise the capacity of their production facilities to cover high fixed costs. Compared to the other institutional roles, the suppliers usually have large fixed costs based on investments in production facilities. This makes them less agile in terms of scaling the organisation to the market and thus they work with longer time horizons - up to 30 years. The value proposition of the supplier centres around providing products on time with a minimum of flaws. Consequently, material suppliers have capabilities within supply chain logistics and strive to avoid legal responsibilities for erroneous handling of their products during the construction process.

The suppliers focus intensively on developing good relationships with their customers, which typically include large contractors and wholesalers. Although architects are not direct customers, material suppliers tend to prioritise showcasing products to architects to influence purchasing decisions derived from the early design phases. Thus, architectural offices often include a substantial amount of demo products to increase visibility of suppliers' products. To stay competitive, suppliers focus on utilizing their production capacity. This includes sustaining and developing capabilities within automation, lean production and digitalization. In addition, suppliers emphasise the importance of new product development to respond to changing user requirements. However, given the high cost of production facilities, the innovation and variance of



products tend to be constrained by the capabilities of the production system.

Furthermore, many suppliers struggle to remove products from the market although new products are launched, resulting in a high degree of product variance and high complexity costs.

### *Practitioner validation*

In the interview with the practitioner from a major supplier of construction materials and systems, it became apparent that the use of business models to understand business practices were an established practice. This was both in terms of formalized company systems put in place around developing business models as well as several useful models to analyse the company, new markets or products the interviewee had gathered from past experience. While the interviewee found the supplier archetype to be adequate for the present state of the general case for a material supplier, the future of the value proposition was likely to expand.

“We supply the people on the building site with calculation tools where they can evaluate if they need a 2.7 meter element or if it is a better solution with a 1.2 meter element which then requires a joint. As part of the tool there are sustainability parameters and comfort parameters which are on peoples’ minds, but they mostly consider these for when the building is finished and the subsequent users. We expand these sustainability parameters so they also include the people on the worksite, so we can reduce the number of people who need to go into early retirement due to for instance handling heavy components.”

This expansion of the sustainability agenda into social sustainability with regard to worker health and safety is a parameter, which traditionally has been handled by regulations and unions. These value propositions are not targeting the traditional customer groups like the end user or the building client but other parts of the construction value chain.

### *Literature validation*

In Lessing & Brege (2018) study of ten Swedish and North American suppliers of building components there are a number of general attributes of the companies that closely resemble the attributes found in the archetype of a supplier. The Lessing & Brege (2018) study uses a bespoke business model framework with three dimensions; Offering, Market position and Operational platform. In the Offering dimension for the companies there are listed attributes such as “Frame and shell product platform for single family houses”, “Automated production of structural frame.” and “Supply of complete parts kit for these [prefabricated] buildings”. These are mirrored the archetype for the supplier in the profit formula attribute “Sales of products and systems”. In the Operational platform dimension eight out of ten have “In-house product development” or “In-house design”, which mirror the Process in the archetype of “Develop new products / new markets”.

Since the study is of vertically integrated suppliers there are also the business model deviates from the archetype in the Market Position category. Six of the ten companies have a “Design and build contractor” strategy of their own products.

### **Identifying friction using the archetypes**

Following the development of the four business model archetypes, frictions between the business model archetypes can be identified when boundaries change. There are two types of friction identified in the transition from an archetypical way of doing business to a strategic partnership; internal company friction from business model change and friction between business models in the value chain. The points of friction identified between the AEC archetypical business models and the AEC business models in a strategic partnership can be seen in Table 4.

Table 4 Identified points of friction between archetypes and strategic partnership AEC business models (Grey cells are internal friction and white are external friction)

Friction with Archetype	SP Architect	SP Engineer	SP Contractor	SP Supplier
<b>Architect</b>	Value proposition: <ul style="list-style-type: none"> <li>Sufficient focus on aesthetics</li> </ul> Profit formula: <ul style="list-style-type: none"> <li>Replicated solutions</li> </ul> Resources: <ul style="list-style-type: none"> <li>Competences for integrated teams and portfolio management</li> </ul>	Process: <ul style="list-style-type: none"> <li>Engineer has influence on architectural design</li> <li>Dividing project management responsibility</li> </ul>	Process: <ul style="list-style-type: none"> <li>Contractor has influence on architectural design</li> </ul>	Process: <ul style="list-style-type: none"> <li>Supplier may have influence architectural design</li> </ul>
<b>Engineer</b>	Process: <ul style="list-style-type: none"> <li>Architect has an influence on engineering design</li> <li>Dividing project management responsibility</li> </ul>	Resources: <ul style="list-style-type: none"> <li>Competences for integrated teams and portfolio management</li> </ul> Process: <ul style="list-style-type: none"> <li>Using in-house resources effectively</li> </ul>	Process: <ul style="list-style-type: none"> <li>Contractor has influence on engineering design</li> <li>Deliver the right level of documentation</li> </ul>	Process: <ul style="list-style-type: none"> <li>Supplier may have influence on engineering design</li> </ul>
<b>Contractor</b>	Resources: <ul style="list-style-type: none"> <li>Employees for competent early involvement</li> </ul>	Resources: <ul style="list-style-type: none"> <li>Employees for competent early involvement</li> </ul> Process: <ul style="list-style-type: none"> <li>Define the right level of documentation</li> </ul>	Profit formula: <ul style="list-style-type: none"> <li>Consultancy as a revenue stream</li> <li>Open books</li> </ul> Resources: <ul style="list-style-type: none"> <li>Competences for integrated teams, portfolio management and consultancy</li> </ul>	Process: <ul style="list-style-type: none"> <li>Supplier may have influence on choice of materials</li> </ul>
<b>Supplier</b>	Resources: <ul style="list-style-type: none"> <li>Employees for competent early involvement</li> </ul>	Resources: <ul style="list-style-type: none"> <li>Employees for competent early involvement</li> </ul>	Resources: <ul style="list-style-type: none"> <li>Employees for competent early involvement</li> </ul>	Profit formula: <ul style="list-style-type: none"> <li>Consultancy to be included</li> <li>Open books</li> </ul> Resources: <ul style="list-style-type: none"> <li>Competences for integrated teams and portfolio management and consultancy</li> </ul>

### *The architect archetype*

As an architectural firm enters into a strategic partnership this will bring a number of friction points in terms of the archetypical business model. Especially in the value proposition category and getting sufficient focus on “high architectural quality” and “art”. Where the early design phase of a typical construction project sees fairly few interests represented, in a strategic partnership project as a minimum both the engineering and contractor have direct influence as well as the building client. There is also the role of project management that needs to be settled with the other participants in the strategic partnership.

These long-term contracts are however very conducive to the value proposition of “advising the client” and in an interview with an architect there was an example given where a private company used long-term agreements because this was a key value.

“A large pharmaceutical company had a long-term agreement with an architectural firm. They had had this contract in... let’s say forever [laughter]. They knew very well that this long-term agreement meant that there were sometimes problems with low performance of the architecture firm, but the pharmaceutical company had some other values that they could not get fulfilled if they changed architectural firm. The client wanted transparency and if there were any problems with a project they wanted to know. They wanted loyalty.”

There is potential friction associated with the archetypical architect profit formula. The possible friction issue is that as solutions in the portfolio are replicated, the need for designing new building elements may go down. When previous good designs are reused in future projects in the portfolio this means less hours for the design. This may be offset by profit sharing or other schemes put in place to incentivise efficiencies in the strategic partnership projects. There may occur friction in terms of getting people who

work well in diverse and integrated teams across companies and backgrounds; little other friction has been identified from the archetypes.

### ***The engineer archetype***

An engineering and consulting firm will have an unchanged value proposition in a strategic partnership project compared to a traditional building project. They will likely meet some friction when integrating the strong professionally skilled employees into cross-disciplinary teams. This may lead them to need new resources in terms of people who can work in this new context.

One of the interviewees said that the strategic partnership as with any other framework contract is valuable because it provides more certainty about future work, and thus the long-term planning of the company becomes easier. Another point can be summarised by the following quote:

As a big consulting firm with many specialities in-house, we are always looking to serve our clients in the best possible way. We strive to add value to our clients.

They may ask for one thing and after a short conversation it becomes evident that what they actually need are different things. In a strategic partnership this type of additional sales is very attractive for us since we can use our size and that we have many in-house capabilities as an advantage for the partnership to create value to our clients.

To fulfil this potential, the consulting firm must have people with broad knowledge of which services the company provides and their availability. This person needs to be part of the active decision and planning process of the strategic partnership, to make recommendations at an appropriate time. If a department from the company must deliver services to the strategic partnership, they also need to understand the special circumstances and agreements that are in a strategic partnership.

Creating this understanding and processes to support it can be a source of friction and may be a challenge when maximizing the effectiveness of this business model change. A new process needs to be implemented in the business model where a capability to understand internal capacity and capability across the engineering disciplines needs to be coupled to an understanding of the capabilities of other organizations in the strategic partnership. This will cause friction due to higher initial costs, time in coordinating and may need new personnel to execute.

### ***The contractor archetype***

Most notably when a contractor enters into a strategic partnering project this changes the profit formula. The early involvement of personnel in the design phase means that a part of the income from the project will be paid as a consultant. Due to the open books, it is also not possible to use procurement practices to cover optimistic budget estimations. The friction from changing the profit formula can be significant.

In terms of resources the contractor needs people who can give productive feedback in the early design phase and this may require retraining or finding new employees. There is also the possibility to make more strategic decisions and have more long-term strategy in the portfolio planning, exemplified with this quote from an interview with a contractor:

“[In a strategic partnership] together with a consultant, together with a building client we can say; how can we do urban development? How can we get most value for money? Etc. Which projects should be promoted first because we then utilize our capacity and the knowledge that the contractor and consultant have together? Which also may mean that a project may actually have to lie on ice for two years but then we have that resource back and then we give it full throttle. In the mean time we can do some other projects now because there we have those people in-house. It provides a completely different access to know-how and capacity.”

The value proposition will in all likelihood change significantly in a strategic partnership and as such will be the source of internal friction. When the contractor in the early design phase needs to have skilled employees who are compensated as a consultant this is very different from what an archetypical contractor does.

### ***The supplier archetype***

For a supplier of building materials to enter into a strategic partnership setup requires the company to make the largest change from its archetypical place in the construction value chain. They like the contractor will see a significant friction when it comes to changing the profit formula of the company. From a profit formula focused on “sales of products and systems” the early design process requires a change to a consultant role and a focus away from own products. This also requires new resources in terms of having personal who have knowledge of the company’s products and capabilities and at the same time can make honest recommendations based on what is good for the project.

In terms of value proposition this remains fairly unchanged but it may require some investigation into what value propositions can additionally be created to serve the whole project and all the stakeholders.

### **Discussion**

According to Teece (2010) a business model is more generic than a business strategy. He advocates for thorough analysis of the value chain in order to design good business models. Since the design of AEC business models is largely role based following archetypical patterns there is a lot of potential for business model design to improve the AEC value chain. Changing business models in a company is however a very difficult task but it starts with knowing where the problem or friction is. We have in this paper connected business models research with the institutional roles of the AEC industry and

their transformation when entering strategic partnerships. The results are four archetypical business models and framework for exploring frictions in and among AEC businesses.

Through the literature study, workshops and interviews the study has found a large number of business model frameworks being used in the AEC business model research. While diversity has a quality, the bespoke nature of many frameworks makes comparison and evaluation of business models hard. If the field of AEC business models research is to develop there needs to be some kind of consensus and consolidation in the business model frameworks used in AEC business model research. This should be a topic of further study and research.

The study confirms the difficulty in dialogue with practitioners using complex business models experienced by Pekuri et al. (2013), Abuzeinab et al. (2014) and Bos-De Vos (2017). The use of the simple FBBM framework by Christensen et al. (2016) was found to make the dialogue easier than using the more complex BMC framework, but business models is still a fairly abstract concept, which most practitioners are unfamiliar with.

The construction client can by the way they formulate tendering conditions promote specific forms of strategic partnerships, which requires new integrated business models, where companies from different parts of the value chain must engage in long-term collaboration on a project portfolio. This paper does not describe the archetypical business model of construction clients. This is a limitation, which should be addressed in further research on strategic partnerships.

The suggested framework of business model archetypes and concept of friction enables further analysis of the implication of transformational practices along the AEC value chain. Thereby we contribute to the ongoing debate and efforts on transforming



construction through new digital technologies, offsite manufacturing, contractual forms as suggested in the Construction sector deal (HM Government, 2018) and the resulting Transforming construction challenge (UKRI, 2021).

Another topic concerns the gradual development of business models.

Christensen et al. (2016) suggest that business models remain stable over time, but also that they can be developed through gradual experimentation. Thereby the framework can be used as a platform for development and maturation of new business models.

## **Conclusion**

In answering the research question this paper contributes with guidance for which business model frameworks are appropriate for analysing the construction industry and engaging with practitioners. Four business model archetypes have been identified, described, and validated, which can be used for analysis. Points of friction have been identified when these business model archetypes encounter new cross value chain interactions in strategic partnerships. Understanding the different business model archetypes in the construction industry will not directly solve these challenges and points of friction, but business models can be a tool to understand and develop the construction industry.

Friction was analysed as the business model archetypes interact in new ways in strategic partnerships. The archetypes were developed using the FBBM framework developed by Christensen et al., (2016) with four dimensions; Value proposition, Profit formula, Resources and Processes. Architect archetypes face internal friction with regard to the value proposition “Sufficient focus on aesthetics”, profit formula “Replicated solutions” and resources “Competences for integrated teams and portfolio management”. The external friction with other business models were in processes where

engineers, contractors and material suppliers have influence on design decisions. To remedy the friction in the profit formula for the architect archetype a form of profit sharing could be introduced in the strategic partnership. The engineering archetypes has internal friction in resources “Competences for integrated teams and portfolio management” and the process “Using in-house resources effectively”. As external frictions are in the engineer archetype processes since they have to coordinate with specialists from other companies. A contractor archetype has internal friction in a strategic partnership in the profit formula with “Consultancy as a revenue stream” and “open books” and in resources with “Competences for integrated teams, portfolio management and consultancy”. The external friction is resources “Employees for competent early involvement” and supplier having influence on building material selection. Supplier archetypes faces internal friction in a strategic partnership similar to the contractor and external friction is in resources “Employees for competent early involvement”.

Further research can use the four archetypes as a starting point, e.g. in the alignment of business models in a business network context or business model innovation. Knowing the current starting point is paramount in our understanding and development of the business models in the AEC industry.

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There have been no conflict of interest related to the research presented in this paper.

### **Data availability**

The data generated during workshops and interviews, which the analysis and business models are based on, are of a personal and sensitive nature and can only be accessed by directly contacting the corresponding author and subsequently obtaining written consent from the participant(s).

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