

MATURITY MODEL FOR STRATEGIC COLLABORATION IN SUSTAINABLE BUILDING RENOVATION

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To enable the construction industry to execute sustainable renovation projects which entails a reduction in use of resources, an increase in productivity and a more socially sustainable construction process, new tools are needed. A maturity model can be a simple and effective tool for a company to evaluate the quality of a process and in recent years a number of maturity models have been proposed to evaluate the construction industry. The construction industry has seen a trend in the last couple of decades towards a higher level of integration of the supply chain and strategic collaboration can now be found in several countries. A maturity model has been synthesized from the examples and experiences of the construction industry based on, interviews, workshops and case studies, to further develop the potential within strategic collaboration. The maturity model can potentially be used as a research tool to analyse why some strategic collaborations are successful and others not. With the model companies in the construction industry are able to make an assessment of their own development potential regarding strategic collaboration and be guided in their further development.

Keywords: building renovation, maturity model, strategic collaboration, sustainability

INTRODUCTION

The built environment is at the heart of our modern society. We spend more than 90 % of our time in buildings and they create the space for work, social interactions and are our homes (WHO 2014).

But the building stock is aging. More than 90% of the current building stock in Europe was constructed before 1990 and most of this will still be standing in 2050 due to the low rate of demolition (Artola *et al.*, 2016). Furthermore, our knowledge and understanding of how buildings influence our productivity, health and wellbeing has increased tremendously since these buildings were built and so there is numerous reasons for bringing the building stock into the 21st century (Acre and Wyckmans 2015). There is also an increased awareness of the impact our buildings and the construction of buildings has on the environment. The buildings in Europe constitute 40 % of the total final energy use and this is another reason why the renovation of our buildings should reduce the energy use (Buildings Performance Institute Europe 2011).

The building industry has access to a wide range of technology, which only a few decades ago was unthinkable. Building Information Modelling has transformed the way buildings

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are designed, Virtual Digital Construction enables the whole building process to be simulated before even the first construction equipment is brought on-site and cheap networked sensors enable a much greater understanding of the current building performance and aids in assessing damage or where the renovation focus should be.

With all the new demands for improved building quality and performance and all the new tools available it is striking, how little the actual process of how we build has changed. By and large the traditional division of labour and the way most buildings are procured is the same as it has been for decades. And this has been suggested as one of the main reasons why the construction industry finds itself in a productivity crisis, with low innovation and frequent conflicts (Clarke and Wall 2000) (Haugseth *et al.*, 2014).

The purpose of this paper is to examine how the construction industry can take advantage of strategic collaboration as a way to change their traditional construction process. This is done by proposing a maturity model, which uses the different approaches found in the construction industry today and enables the companies to access themselves and others.

Strategic collaboration has been found to be a very potent tool to improve the budget certainty, improve building quality and reduce conflicts in construction projects. It enables organizational learning and has been used as an innovation tool (Dewulf and Kadefors 2012). The use of strategic collaboration in the construction industry on a large scale can be found in the UK programme "Achieving Excellence" launched in 1999 by the Office of Government Commerce (OGC). Based on the ideas found in "Constructing the Team" (1994) by Sir Michael Latham and "Rethinking Construction" (1998) by Sir John Egan - also known as the Egan report (Government Construction Client Panel 1999) (Sustainability Construction Action group of the GCCP 2000). A National Audit Office report "Improving Public Services through Better Construction" (2005) found that this approach had led to substantial results in the span of only five years. Public construction projects finished to budget was up from 25% in 1999 to 55% in 2004 and project delivered on time was up from 34% to 63%.

This approach has subsequently been copied by Swedish municipalities with a wide range of benefits from increased quality of buildings to a better work environment reducing employee turnover and enabling talent retention (Kadefors *et al.*, 2013).

It is therefore of great interest to construction industries in countries with little or no experience with strategic collaboration to learn how to make a transition to reap the benefits of strategic collaboration. The maturity model is one way for companies and clients to start this transformation and to highlight the requirements for executing successful strategic collaborations. The Danish construction industry has therefore been the subject for this research.

THE ORIGIN AND TYPES OF MATURITY MODELS

To understand complex processes and to direct an organization in a given direction models are of tremendous value. They highlight key aspects which needs attention and enables management to make sound and logical steps to improve the quality of a given process (Wendler 2012).

Maturity models first saw widespread adoption in the early 90's in the software industry and has since then spread to other fields. The Capability Maturity Model for Software (CMM) was developed by the Software Engineering Institute (SEI) to assess the capability of software contractors.

The CMM was based on the notion that there were five discrete observable states which the software development process could have; Initial, Repeatable, Defined, Managed and Optimizing (Paulk *et al.*, 1993).

Maturity models have been further developed in a multitude of contexts and to assess a wide variety of processes. They fundamentally fall into two categories or perspectives; life cycle perspective or a potential performance perspective (McBride 2010).

Maturity models based on the lifecycle perspective describe a process, which starts at a beginning stage, immature, and over time the process will naturally progress to the end stage, maturity. In this type of model the progression through the maturity model stages will naturally happen due to improvements and learning effects but can be accelerated (Wendler 2012).

Maturity models based on the potential performance perspective in contrast do not have a natural progression through the levels of the model. The model shows the potential benefits of a higher maturity level and it is up to the user to decide if it is desirable to progress to the next level. Most maturity models available today follow this potential performance perspective (McBride 2010).

The maturity model presented in this paper will be utilizing the potential performance perspective, since the construction process is heavily influenced by the nature of the specific project and the relations between the stakeholders in the individual project or project portfolio. It is therefore not a given that construction projects starting out with a low level of maturity will progress to a higher level of maturity and in some cases it will not be advantageous to have a high level of maturity since this entails a higher level of complexity which e.g. for small and easily defined construction projects do not provide substantial value.

In the following sections the literature on the subject of maturity models and construction will be reviewed as well as some of the application areas within construction where maturity models have been used.

LITERATURE SEARCH METHOD

An extensive literature search has been conducted to serve as inspiration and as a theoretical foundation for the maturity model presented in this paper. The literature search has utilized a number of search engines, both scientific and public to get a general understanding of the variety and use of maturity models in construction.

As method a broad search was applied using search terms with Boolean operators. The subsequent results were categorized according to relevance by title and relevance by abstract content. Maturity models used to evaluate IT systems like Building Information Modelling tools were excluded from the search, since this paper concerns a maturity model focused on the construction process.

Following the identification of relevant literature, a full reading of the entire text was condensed into a document containing relevant models and important observations to be used as the basis of the model creation.

Pivotal works were also identified through an analysis of cross references in the literature found in the search.

MATURITY MODELS IN CONSTRUCTION

A maturity model review article published in 2012 (Wendler 2012) analyses a great number of scientific papers to identify the use and application area of maturity models. In

the article 10 papers are identified as having a focus on the application of maturity models to "Construction Processes / Engineering".

In the literature review done for this paper, a number of recently published maturity models relating to the construction process were identified. The Public Commissioning Maturity Model (PCMM) first published in 2014 was made to raise awareness among public construction clients' organisations (Hermans *et al.*, 2014). A model focusing on the maturity of the construction management organization was published in 2016 and named Management Maturity Model (MMM). (Langston and Ghanbaripour 2016) In order for a construction organization to guide innovation actions the Collaborative Innovation Capability Maturity Model (CICMM) was published in 2015 (Knoke 2015).

Some maturity models utilized Key Performance Indicators (KPI) as a measurement tool, while others describe the levels by Key Attributes (KA) to describe different behaviour at the different maturity levels.

As can be seen by the previous three examples a maturity model lends itself to explore and quantify a number of different topics within construction management. As a pivotal work with numerous citations in relevant literature "Maturity model for supply chain relationships in construction" has been identified.(Meng *et al.*, 2011) The maturity model presented in that paper consist of four levels and eight main criteria are used to describe the different levels.

The model was tested in a case study of a building project with a public sector client in the United Kingdom. This showed that in individual projects there is a tendency to start out at a low level, Level 1, and throughout the project phases the relationship can progress to higher levels. It was concluded that to achieve relationship improvements it is very valuable to have an appropriate measuring tool and a maturity model can be useful in this regard.

EMPIRICAL INFORMATION GATHERING

As part of gathering empirical information to lay the foundation to create the Strategic Collaboration in Construction Maturity Model (SCCMM) previous published work was used together with industry surveys conducted previously. The potential for improving the construction process in building renovation was identified by a survey conducted in 2014 with 277 participants from the Danish building industry. This survey identified the construction process as the area with the highest potential for improvement among the survey participants (Uhd and Hornbek 2014). A number of case descriptions from the UK and Sweden were used to determine how the renovation process could be improved and strategic collaboration was found to be a potent driver for improving construction project on multiple parameters.

Two workshops were conducted in autumn 2016 with participants spanning the Danish building industry from architects, consulting engineering, contractors to producers of building components and social housing non-profits as clients. The goal was to examine the challenges in the existing building renovation process and to examine how strategic partnerships could be used as a method to meet some of these challenges. An in-depth description of this process can be found in (Jensen *et al.*, 2017) and the conclusions on the prerequisites of strategic collaboration.

As a result of these workshops it became apparent that the participants were very interested in a way to discriminate between different levels of collaboration. To facilitate discussions and to make informed decisions regarding collaboration, the authors

introduced the workshop participants for the concept of maturity models. Following this introduction to the concept, individual interviews were conducted to identify how, why and to which extent the participants had experience with different collaboration types. This was done using the semi-structured research interview method (Kvale 2009) with critical incident technique (Miles and Huberman 1994). Six one and a half hour interviews were conducted and analysed over the course of six months in the winter and spring of 2016-2017 among the above mentioned parties leading to the development of the development of the Strategic Collaboration in Construction Maturity Model (SCCMM).

The analysis method used to arrive at the model is based on the Template Analysis method using existing construction industry related maturity models as an inspiration for the prior category generation (King 2004)(Saunders *et al.*, 2009). The transcription of the interviews as well as the coding and analysis was done using NVivo 11 software.

THE STRATEGIC COLLABORATION IN CONSTRUCTION MATURITY MODEL

During the workshops, interviews and case studies previously described, it was found that existing maturity models did not sufficiently describe the possible construction process configurations.

"There is a tendency to view renovation projects as not being different from other types of construction. This is not the case since you have to take into account both the existing building, tenants and the building operator." (Translated) - Head of division, contractor [participant in workshop].

An example which was not covered by (Meng *et al.*, 2011) was found in framework contracts which contained multiple renovation projects but where the only selection criteria were price. In such a project organizational learning is possible but limited, there is the advantage of repetition but low or no cost transparency. This was not seen as sufficient covered by previously proposed models and led to the creation of a new maturity model described in his section.

The Strategic Collaboration in Construction Maturity Model (SCCMM), seen in figure 1, consists of five maturity steps defined by two axes; Complexity and Value. The Complexity dimension denotes the different challenges and requirements associated with moving to a higher maturity level. In the Value dimension the possible benefits can be described.

Level 1: Price	The only evaluation parameter in a given tender is price
Level 2: Value for money	The evaluation parameter is to a lesser degree price and other parameters are considered such as quality, work safety, sustainability profile and other.
Level 3: Development	The evaluation parameter involves price, quality and some form of development goal such as a product or a service
Level 4: Strategic partner	The evaluation parameters involves price, quality, development goals and there is focus on improving process links between the companies in the building process.

Level 5: Strategic collaboration

The evaluation parameters involve price, quality, development goals, improving process and there is a firm commitment from top management to prioritize the collaboration.

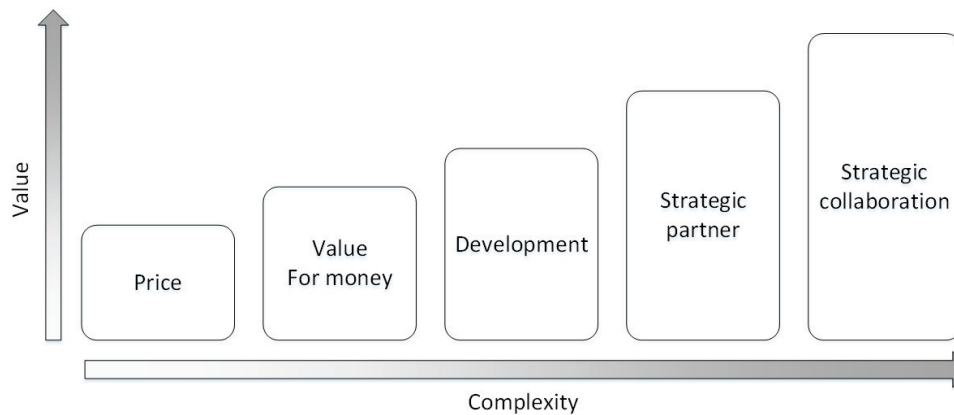


Figure 1: Strategic Collaboration in Construction Maturity Model's graphical representation.

At level 1 price is the only evaluation criteria and while this is a very simple metric and easy to communicate, it is also a very simplistic evaluation method. It is however, the most common way of procuring renovation projects reported by all participants in the workshops and interviews described previously. Progressing from this to level 2, the evaluation criteria become more numerous and price does not take centre stage but a number of criteria are used to evaluate the tenders received. This is a way of procuring, which all participants were familiar with, but it is by no means the norm. Renovation projects with a development dimension as described in level 3 were also something, which all of the construction companies interviewed were familiar with and seen as a way of aligning goals between the companies in the renovation process. The use of strategic partners was not common among the participants although it was found that many did have strategic partnerships with other companies outside the construction industry; usually with regard to secondary services e.g. work clothes procurement. Strategic collaboration as described by the literature from the UK and Sweden was not something the participants had first-hand experience with but something which they saw as having great potential.

It is important to note that since the maturity model is based on the potential performance perspective, it does not present a natural progression, although in many projects this progression happens unintentionally and unguided; some construction projects will benefit from a lower maturity level and others from a higher (Meng *et al.*, 2011).

It was also deemed necessary to formulate two maturity models one for single projects and the other for project portfolios. Although they share the same structure seen in figure 1 they differ in the Key Attributes of the description of the complexity and value dimensions.

Single Projects Key Attributes

Complexity

The evaluation criteria become more qualitative and numerous with each maturity step. For each step of maturity level increase, a higher level of senior management involvement is required and communication is required on multiple management levels. In the

construction project organization each maturity step means extra effort is required to align goals, values and improve inter-organizational communication.

Value

A key aspect of getting a higher maturity level in a project is the possibility to get a greater budget transparency, which means that design choices and changes can be made with a greater understanding of the impact on final renovation cost and quality. With higher maturity levels, it is also possible to draw on experience and expertise from multiple professions, while making assessments of the existing building. It is possible to change incentive structures with higher levels of maturity to achieve shared pain and shared gain as well as risk sharing. Higher maturity levels also offers more control in terms of price and quality of the renovation being performed and as such can be used as a driver to achieve higher performance in terms of sustainability parameters.

Project Portfolio Key Attributes

In a project portfolio consisting of several renovation projects the construction project organization can be used on multiple renovation sites and this affords a number of advantages. The organization can also evolve more independent of the companies involved in terms of maturity level. While project portfolios have overlapping Complexity and Value descriptions with single projects, some further traits can be identified.

Complexity

Cost competitiveness with market prices becomes less transparent with higher levels of maturity and requires dedicated research and attention.

Value

It is possible to improve process performance and increase development and testing of innovative solutions when using higher levels of maturity. Higher maturity levels also enable increased use of dedicated renovation process facilitators, who can improve building quality to meet the requirements of multiple stakeholders.

Application of Key Attributes

To make the model operational a table can be formed using the KA's described in the previous two subsections. In this table the complexity and value KA's can be seen separately and scored from maturity level 1 to 5 when analysing a renovation project. The KA evaluation table can be seen in table 1. Attributes marked with * in table 1 are relevant for project portfolios.

Following this analysis it is possible to ascertain if a current renovation process has the desired maturity level. It is also possible to identify KA's which need attention to improve the current maturity level.

Table 1: Key attribute evaluation table for SCCMM

Maturity level	Level 1	Level 2	Level 3	Level 4	Level 5
Maturity requirement for level	Very low	Low	Moderate	High	Very high
Complexity	Complexity of tender bid evaluation				
	Number of qualitative tender bid evaluation criteria				
	Senior management involvement				
	Number of management communication levels				
	Goal alignment				
	Company value alignment				
	Quality of inter-organizational communication				
	Attention required to ascertain market prices of renovation*				
Value	Budget transparency				
	Transparent link between design changes and renovation cost				
	Transparent link between renovation cost and quality				
	Pre-renovation building assessment with input from multiple professions				
	Incentive structure with shared pain/gain				
	Risk sharing and holistic risk management				
	Control of price related to quality				
	Control of sustainability parameters				
	Development and testing of innovative solutions*				
	Dedicated renovation process facilitators*				
*Specific KA's of project portfolios					

DISCUSSION AND FURTHER RESEARCH

A maturity model can be used to describe the very complex interactions, which take place in a renovation process in a way that enable clients and the renovation design and construction teams to evaluate their processes and relationships. While models emphasize certain aspects of the renovation process, using the model requires that the project at hand is suited to be evaluated by the said model.

The maturity model presented in this paper takes in to account not only the benefits of increasing maturity level but also the challenges associated with this transition. This is done to highlight the fact that it is not trivial to increase maturity level and not all renovation projects are suited for very high levels of maturity.

It is important that both the client and the design and construction team have the necessary competences to execute projects with high maturity levels. If there is not a sufficient understanding of the importance of goal alignment, management engagement or other vital aspects, the project will not be able to realize the expected benefits.

As a topic of further research, validating the model on renovation projects with different client types and with different types of renovation project organizations is essential. This

can be done by using the model to analyse construction clients and construction project organizations to help determine the level of maturity and then compare this to the described maturity in the individual project. It would then also be possible to get feedback from practitioners on, whether or not the KA's are sufficient or should be modified.

Generalizing the maturity model to study supply chain behaviour in other fields with relation to construction could also yield interesting insights.

CONCLUSIONS

The maturity model presented in this paper, Strategic Collaboration in Construction Maturity Model (SCCMM), consists of five steps; Price, Value for money, Development, Strategic partner, Strategic collaboration. To describe these five steps, two dimensions are used, Complexity and Value, to pinpoint the challenges and potential performance benefits, respectively. The model was developed based on case studies, workshops and interviews with building industry experts from across the building industry.

The SCCMM can potentially be used as a research tool to analyse, why some strategic collaborations are successful and others not. It can also be used by the client or the renovation design and construction organizations to evaluate their process in terms of, which level of maturity is suitable for the individual renovation project or portfolio. This will enable the renovation process to be tailored to suite the project requirements and enable higher budget certainty, increase renovation efficiency and facilitate sustainable building renovations.

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