

Consultants as systems integrator?! – a case study in the Dutch construction industry

WOUTER GROOTERS

Department of Construction Management and Engineering, Faculty of Engineering Technology, University of Twente., the Netherlands

Abstract:

The current role of the consultant in the construction industry is often passive and involves consultancy or the elaboration of designs. Consultants believe that a lot of professional in-house knowledge is not used and opportunities may remain unused. Nowadays, governments are transferring more tasks and responsibilities to the market offering consultants the opportunity to change their role. Nevertheless, when taking the systems integrator perspective, a major question still remains, namely to what extent consultants can move away from its consultancy role and can take a more directing, coordinating and risk-bearing role in the construction industry.

This paper presents a case study about bouwteams¹ (hereafter referred to as the CB-team) in the Dutch construction industry. The results from the case study show that consultants can take a more directing, coordinating and risk-bearing role in CB-teams. It depends on the type of client and client's needs to what extent consultants can take this role. Furthermore, this research concludes that becoming a systems integrator in CB-teams is a step too far, especially in the public market. Some thresholds need to be removed by the consultant such as the willingness of consultants to abandon the limitations of their design liability, contractors who process themselves to be the 'central' party in the process and the traditional attitude of public clients.

In addition, this research has found that 'CB-team' and 'systems integrator' must be kept separate and cannot be integrated, as the fundamentals of both terms contradict each other. Therefore, it is not possible to become a systems integrator in CB-teams. This research shows that participating in CB-teams could be the first step to develop into a systems integrator. A model is presented which describes the different steps consultants must take to develop from a jobber to a systems integrator. The model appoints which competences the consultant needs to develop and which limitations should be taken into account.

Key words: systems integrator, Dutch construction industry, consultants, engineering firms, bouwteam, competences, jobber

1. Introduction

Since the collusion in the Dutch construction industry in 2001, the relationships between market parties and public clients have changed dramatically. More distance has been created and more rules have been set to regulate the procurement of construction works in the public sector [1] [2]. This formalization resulted in claims about additional work and a regulation of the market [2]. In the current competitive market, parties are focusing too much on the organization's own interests and, unfortunately, not enough on the alignment of interests and the organization of cooperation between parties [3] [4] [5]. Additionally, governments in the Netherlands become smaller, as a consequence more tasks and responsibilities are being transferred to the market [6]. At the same time, public clients want to retain influence on the design and the quality of the solutions offered. In the Netherlands more clients experience a CB-team as a pleasant type of cooperation, where responsibilities can be transferred to the contractor in a responsible manner without losing influence on the design and the quality of the solutions offered [3] [7].

This research focuses on the role of the consultant in CB-teams. The current role of the consultant in a CB-team is often passive and involves consultancy or the elaboration of designs (capacity supplier) [3] [8]. Consultants believe that a lot of professional in-house knowledge is currently not used and opportunities may remain unused. In addition, consultants experience price pressure [8]. Nowadays, governments are transferring more tasks and

responsibilities to the market offering consultants the opportunity to move away from its consultancy role to a more directing role in CB-teams. As a result, in combination with taking design reliability, consultants will develop towards a role as a systems integrator in the Dutch construction industry [9].

For this reason, the steps a consultant has to take to turn from a capacity supplier (jobber) to a systems integrator need to be analyzed. In this research, a case study is conducted within the organization of the Dutch consultant Aveco de Bondt. Aveco de Bondt is a consultant with around 370 employees (fte) and a yearly turn-over of about € 45 million. Aveco de Bondt is active in the Dutch construction industry and part of VolkerWessels, a construction group in the Netherlands which focuses on the design, development, construction and management of construction projects.

A definition of the Dutch term 'CB-team'

Before moving on to the theoretical framework, the term 'Collaboration team (CB-team)' will be introduced. A CB-team is a type of cooperation between client, contractor and consultant(s). Design and construction professionals are appointed early in the project development process, to assist in designing, assessing constructability, stakeholder management and risk management [10]. Using CB-teams will result in an (1) improved project delivery, (2) reduced project costs and / or (3) reduced overruns of time and cost [11] [12] [13].

¹ Bouwteam: A comprehensive definition of the term bouwteam, hereafter referred to as the CB-team (collaboration team), is to be found in the introduction: *Introduction* -> *A definition of the Dutch term 'CB-team'*

A CB-team comprises two phases with separate contracts for each phase. Phase 1 involves a typical professional consultancy agreement between client, contractor and/or consultant, which includes the design progress from a preliminary design to a detailed design [14]. Phase 2 includes a construction agreement between client and contractor, which could be a traditional or integrated Design and Construct contract.

Prior to phase 1, bidders do not need to prepare a preliminary design, but are selected through a none-price based selection [15]. During phase 1, construction professionals work together towards achieving certain deliverables which are likely to include (1) identifying and assessing risks associated with the project and (2) developing an appropriate risk management mechanism [14]. Subsequently, the contractor submits an offer for the construction of the project. The contractor of phase 1 is the first and only candidate to submit an offer [16]. If the clients accepts the offer, the contractor carries out construction of the project. If the offer does not meet the project budget or fails to demonstrate value for money, the client gains the intellectual property rights of the design. This enables the client to take the project to the market as a traditional construction contract [17].

2. Theoretical Framework

This section starts with some characteristics of the construction industry. It then presents the systems integrator, the role of the systems integrator and two analytical levels of systems integration. Subsequently, a discussion about the possibilities for consultants to develop into a systems integrator follows. Finally, systems integrator competences and skills are discussed.

2.1 The construction industry

The construction industry is characterized by its highly fragmented supply chain. Knowledge, technologies, materials and skills are dispersed amongst many different organizations, which makes it problematic to develop innovations. Stable and close relationships between parties such as contractors, architects, engineers, suppliers, clients, research institutions and government bodies contribute to the development of innovations and sharing knowledge and risks [18]. In the construction industry products from one supplier influence the demand of products of other suppliers. Therefore, this process asks for a structured way of working with one coordinating organization. If more long-term relationships are present in the network, the project performance will be better, due to the efficient and effective integration of the different phases of the building process [19].

2.2 The systems integrator

According to Rutten et al. (2007), the concept of systems integrators refers to firms that design and produce products that are highly customized, made up of many components, based on multiple technologies and produced in one-off projects or in small batches [18] [20]. Systems integrators add value through systems integration: they integrate components, technologies, skills and knowledge from various organizations into a unified system for an individual customer. Davies, Brady & Hobday (2007) are using the following more practical definition: ‘A systems integrator is a main contractor organization responsible for designing and integrating product and service components supplied by a variety

of external suppliers into a functional system for an individual customer’ [21].

Davies et al. (2007) have drawn up a number of criteria to determine whether an organization could be identified as a systems integrator [21]: (1) The company has full contractual responsibility towards the client of the design and construction of the project, (2) the company works together with several external companies (the network) to offer products and / or services and (3) the company tailors the solution to the individual needs of the customer, including the location specific features.

2.3 The role of the systems integrator

The position of the systems integrator lays between the innovation superstructure and the innovation infrastructure, as shown in figure 1. The innovation superstructure consists out of clients, regulators and professional institutions, whereas the innovation infrastructure consists out of trade contractors, specialist consultants and component suppliers [22].

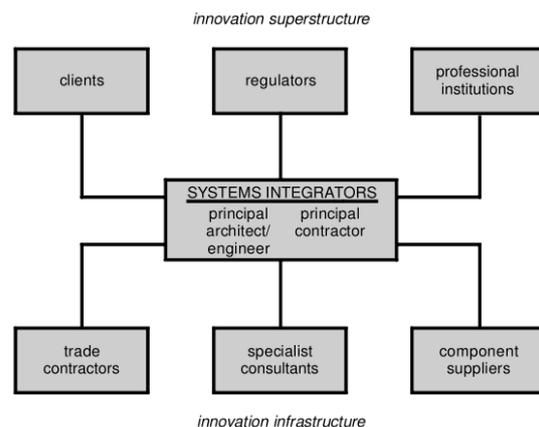


Figure 1 Position of the systems integrator [22]

The most important task of a systems integrator is to organize the activities within the infrastructural network in such a way that they match the constantly changing demand of clients in the innovation superstructure [23]. Therefore, the systems integrator has to (1) set up a network of various organizations and has to (2) coordinate the work of the organizations involved in the network [23] [24] [25].

2.4 Two analytical levels of systems integration

Besides the two different tasks of the systems integrator, two different analytical levels of systems integration can be distinguished [23] [24] [25]: (1) static systems integration and (2) dynamic systems integration. Static systems integration refers to total contractors which set up and coordinate a network of organizations for the design and construction of products within a predefined period and financial budget [18]. Dynamic systems integration includes a more long term view on cooperative relationships.

In general, the role of the systems integrator can be found at firms which provide both design and construction and seek to create competitive advantage by developing a unique product concept in cooperation with other organizations [18]. Therefore, Design-Build (DB) or turnkey contracts are typical projects for systems

integrators [21]. Furthermore, systems integrators are increasingly supplying DB projects in combination with additional services such as finance (F), maintenance (M) and operate (O) [18] [26], so called DBFMO contracts.

2.5 A consultant as systems integrator

Since the percentage of integrated projects is rising in various countries [1], it is plausible to assume that the number of construction projects contracted to a systems integrator will increase [18]. The question is which companies within the construction industry have the capacity to enter the market as a systems integrator. Distinctive of the position of a systems integrator is that parties can take this position only on the basis of available competences [27]. Within the construction industry, with a market of supply and demand for products, control and knowledge about the design is a crucial factor [28]. This knowledge is present at consultants. However, it is not considered by Dorée & Van der Veen (1999) that consultants will develop into systems integrators. The main reason is that consultants have a (1) limited turnover, (2) often have insufficient capital and (3) are limited in their liabilities [28]. Sufficient financial capacity is important to be able to offer risk-bearing integrated solutions.

Dorée & Van der Veen (1999) consider contractors - with some size and experience as main contractor - the most likely parties to develop into systems integrators as they have experience with (1) the coordinating and leading role, (2) risk-bearing operations and (3) turnover power (capital).

Fluor and Cepezed Systems show that even architects and consultants could develop into a systems integrator. Fluor is one of the world's largest engineering, procurement, fabrication, construction and maintenance (EPFCM) companies, providing innovative and integrated solutions to government and private sector clients in diverse industries [29]. Textbox 1 describes briefly why Cepezed decided to enter the market as a systems integrator.

Why Cepezed decided to enter the market as a systems integrator [9] [30]
 Cepezed is an architectural firm which offers building solutions to complex glass / steel constructions. Usually Cepezed made the design and a contractor started to carry out the construction of the project, but often contractors considered the designs of Cepezed to be very complex. Subsequently, Cepezed decided to enter the market as a total contractor, offering the entire project from design to construction. In this way, Cepezed has specialized in a certain product / market technology in which it offers total solutions to the customer.

Textbox 1 Example Cepezed

2.6 Framework of Bonhof: Systems integrator competences and skills

Bonhof (2008) carried out extensive literature research into the required competences to enter the market as a systems integrator [31]. Bonhof used the competence theory, in which knowledge and skills are described as the main resources to creating products with a unique value. Bonhof assumed that all competences are equal and must be developed by the systems integrator company itself. However, a number of comments can be made here. Firstly,

Bonhof did not explain which competences had to be developed first, or which competences were more important than other ones. Secondly, Bonhof assumed that the systems integrator must possess all the competences by itself. However, this is not in line with the characteristics of a systems integrator. According to Miller et al. (1995) and Winch (1998), a systems integrator has a fixed network with partners and therefore does not have to own all the competences by itself [20] [22]. For this reason, this current research will provide more insights in the stratification between the different competences. Besides, this research will show that some tasks are required to develop into a systems integrator, though other tasks could be outsourced to fixed partners within the network.

3. Research methodology

The type of research design used in this research is based on a case study about CB-teams. This papers' section describes the steps taken towards the findings of this research, as displayed in figure 2. It is important to note that the results were obtained through a case study at project level. After that, the results were analyzed to develop a model at organizational level. First, the scope of the case study is given. Next, the theoretical model is presented which shows an overview of competences needed to act as systems integrator. Finally, the case study consisting of interviews and a game is presented.

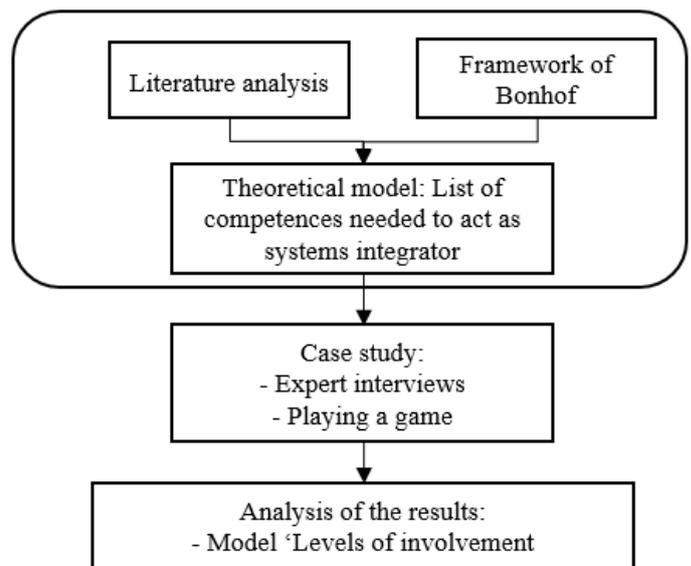


Figure 2 Research design

3.1 Scope of the case study

The choice of projects and experts within this case study were limited to a certain scope. The scope within this research focused primarily on infrastructural projects (1) with a budget of € 1 - 5 million, (2) procured by public municipal clients, (3) executed in a CB-team and (4) awarded based on Most Economically Advantageous Tender (MEAT).

3.2 Theoretical model: List of competences needed to act as systems integrator

Since a CB-team is a Dutch type of cooperation with a number of specific characteristics, the competences and skills described by Bonhof (2008) are not sufficient to cover all tasks found in a CB-team. By combining insights gained on the role of the systems integrator in the literature study and the core tasks of the systems integrator described within the framework of Bonhof, in this current research a revised model is defined which describes the tasks that need to be divided within a CB-team, as displayed in table 1. Some definitions of tasks were changed, a number of tasks were omitted and a few tasks such as cost expertise were added, to make a revised model which matched the CB-teams' characteristics better. The continuation of this research was based on this model. In this revised model the different competences were still shown in a random order.

3.3 The case study

To gain more insights into the way in which tasks are divided between parties, a case study consisting of semi structured interviews (qualitative data) and a specially developed game (qualitative + quantitative data) was used. 28 expert interviews were conducted among nine public clients, nine contractors, three project developers and seven people inside Aveco de Bondt. Employees from clients included project leaders, floor managers and tender specialists. Employees from contractors included directors, project managers or district managers. A number of criteria were formulated to determine the choice of respondents, with the objective to get a mix of smaller and middle size public clients and contractors. Subsequently, the results of the case study were cross-case analyzed.

3.4 The game

During the expert interviews, a game was played. The games' objective was to collect quantitative data about the grouping of tasks between parties. The basis for the game was table 1, which describes the tasks that needed to be divided. The game consisted of a board and related tasks printed on a card, as shown in figure 3. The board shows the three types of parties which can be part of a CB-team: client, consultant and contractor. Added is a box called 'collaboratively', which is used to indicate that the task concerns a collaborative task.

During the game, the following three steps were completed sequentially:

Step 1: Gaining more insights in the present competences

The respondents filled in a questionnaire, in which they had to indicate to what extent the formulated competences were present within their organization. This explained whether the respondent allocated certain roles to himself or outsourced them to other parties.

Step 2: The grouping of tasks in current CB-teams

The respondent was asked to divide the roles as they were distributed in the current situation. Subsequently, the respondent had to give an explanation on his grouping of tasks.

Step 3: The grouping of tasks in the ideal CB-team

The respondent was asked to divide the roles as he thought them can be best distributed. In this step, the respondent was again asked to give an explanation.

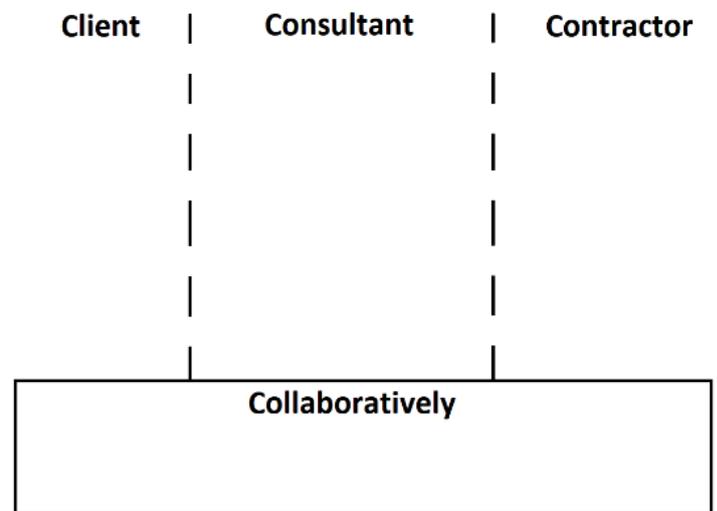


Figure 3 (Playing)board used during games.

<u>Entrepreneurial competences</u>	
Knowledge of market developments	Knowledge of laws and regulations, policy changes and innovations.
Self-knowledge and knowledge of the distinctiveness	Knowledge of the core competences of the organization, knowledge of competitors, strategies and distinctiveness.
Conceptualization of business ideas	Skills regarding the development of concepts (products and / or services) based on a strategic ambition.
Relationship management	Skills regarding structurally maintaining contact with customers, policy makers, knowledge institutions, contractors, etc.
Marketing & acquisition	Skills regarding marketing and developing a strategic ambition.
Acquisition on the basis of concept solutions	Acquiring new customers on the basis of concept solutions.
<u>Process competences</u>	
Integral risk management	Performing integral risk analysis.
<i>Planning management</i>	<i>Being capable of drawing up integral project plans and monitoring deadlines.</i>
Quality management	Being capable of monitoring quality with the objective to perform the project according to the specifications.
<i>Contract management</i>	<i>Drafting contracts and guaranteeing contract agreements.</i>
Legal knowledge	Knowledge of legal liabilities, knowledge of contract forms.
<u>Technical competences</u>	
<i>Designing</i>	<i>Being capable of making designs, skills regarding translating needs into solutions, skills regarding verifying and validating a design.</i>
<i>Proposing design optimizations</i>	<i>Knowledge to create improved designs.</i>
<i>Knowledge of Systems Engineering</i>	<i>Being able to think in functions instead of solutions.</i>
Knowledge of technology and constructions	Knowledge of the most important components of a system.
Permit management	Being capable of managing permit processes.
<i>Cost expertise</i>	<i>Assessing proposed plans, budgets and offers.</i>
<u>Service competences</u>	
Asset management	Skills regarding maintaining objects.
Facility management	Skills regarding exploiting objects.
Financing	Skills regarding financing projects.
<u>Relational competences</u>	
<i>Setting up CB-team</i>	<i>Being able to assess which disciplines should be part of the CB-team, competent in selecting and assessing potential partners, knowledge of cooperation forms.</i>
<i>Coordinating CB-team</i>	<i>Requires management skills, skills in recognizing, valuing and responding to the interests of other parties in CB-team.</i>
Dispute management	Skills regarding preventing and resolving conflicts.
Information management	Skills regarding sharing of information with all participating parties.
Communication management	Stakeholder management which requires skills in mediating between customers and stakeholders. In addition, communication towards the governmental organization, politics etc.
Knowledge management	Being able to identify and share learning points with participating parties.

Table 1 Theoretical model: List of competences needed to act as systems integrator, adapted from Bonhof (2008).

For each competence a brief explanation is given.

The competences shown in italics have been adjusted in relation to the original model of Bonhof, to match the CB-team's characteristics better.

4. Results and findings

In this section, the results and findings of the case study are presented. In paragraph 6, interesting outcomes are discussed and compared with the literature study.

4.1 Results step 1: Gaining more insights in the present competences

Figure 4 displays the results of the questionnaire, in which experts were asked to indicate to what extent the formulated competences were present within their organization. The results are ordered by a score which shows the differences in competences between clients and contractors. As a result, these scores give insights into which competences are more present at clients compared to contractors (or vice versa). In general, more knowledge (on a scale of 1-5) was present at contractors (in average 3.9) compared to public clients (in average 3.6). Regarding present knowledge, there was a larger spread for contractors (standard deviation of 0.61), compared to clients (standard deviation of 0.46). This can partly be explained by the three smaller contractors, who has substantially less knowledge present. Without these three contractors the standard deviation is 0.51.

4.2 Results step 2: The grouping of tasks in current CB-teams

Table 2 displays the grouping of tasks in current CB-teams. Interesting to note; many tasks were perceived as a collaborative tasks and only one task was assigned to the consultant. In this research ‘collaboratively’ means; knowledge of all three parties is required to fulfill this task successfully.

Client	Consultant	Contractor	Collaboratively
Contract management	Skills of designing	Knowledge of technology and constructions	Proposing design optimizations
Cost expertise		Coordinating CB-team	Dispute management
		Communication management	Information management
			Integral risk management
			Legal knowledge
			Knowledge management
			Quality management
			Setting up CB-team
			Planning management
			Permit management

Table 2 The grouping of tasks in current CB-teams

4.3 Results step 3: The grouping of tasks in the ideal CB-team

Table 3 displays the grouping of tasks in the ideal CB-team. Interesting to note; clients and contractors had a different view on the way in which tasks can be best divided. First of all, clients and contractors had a different opinion about the ideal grouping of tasks. Secondly, contractors assigned more tasks to one party (even to themselves), though clients wanted to work more in a collaborative manner. Thirdly, more tasks – in comparison with current CB-teams - are assigned to the consultant.

Black: Consensus between contractors and clients

Underlined: Vision contractors

Italic: Vision clients

Client	Consultant	Contractor	Collaboratively
Contract management	Knowledge of Systems Engineering	Knowledge of technology and constructions	Proposing design optimizations
<i>Setting up project team</i>	Dispute management	<i>Skills of designing</i>	Knowledge management
	<i>Coordinating project team</i>	<u>Communication management</u>	Information management
	<u>Integral risk management</u>	<u>Quality management</u>	Permit management
	<u>Designing</u>	<u>Coordinating project team</u>	Legal knowledge
		<u>Planning management</u>	Cost expertise
			<i>Planning management</i>
			<i>Communication management</i>
			<i>Quality management</i>
			<i>Integral risk management</i>
			<u>Setting up project team</u>

Table 3 Grouping of tasks in the ideal CB-team

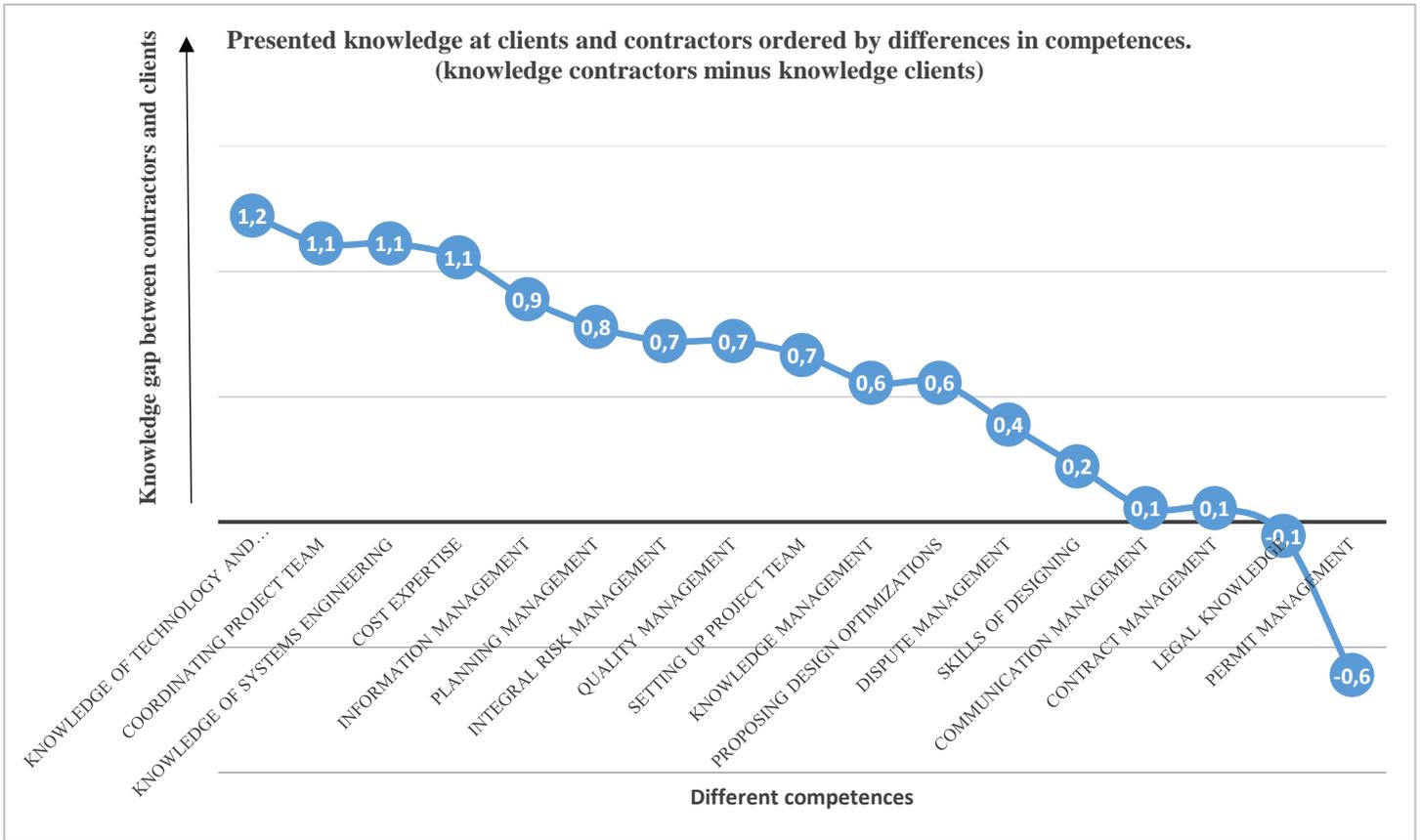


Figure 4 Presented knowledge at clients and contractors ordered by differences in competences.

5. Analysis of the results and findings

To gain more insight in the different roles the consultant could take to develop from a capacity supplier (jobber) to a systems integrator, the results and findings of the case study should be analyzed. From the expert interviews among nine public clients, nine contractors, three project developers and seven people inside Aveco de Bondt, it appears that the way in which a project is designed in a CB-team depends on the type of project (required knowledge and skills) and the needs of the client. A model which ranks the needs of human, is the Pyramid of Maslow. If a need is met, the individual moves on to the next level in which it is not possible to skip certain levels [32]. The idea behind the Pyramid of Maslow with the different conditional levels, has many similarities with the needs of clients in construction projects. For example, the traditional need of public clients is capacity driven. Due to disappearing of knowledge amongst public clients, they have to transfer more responsibilities to their contractors instead of controlling all the processes themselves.

Figure 5 shows the model 'levels of involvement', which characterizes the needs of the client. The model is developed based on the analysis of the results and findings of the case study. For each level the various tasks as mentioned in the theoretical framework are allocated to the different 'levels of involvement'. Furthermore, some limitations which influence the possibilities for consultants are mentioned. Paragraph 6 will take a closer look at these limitations.

The pyramid is created by translating Maslow's Pyramid into the needs of public clients in the construction industry. Firstly, the different research results with regard to the needs of the client are analyzed. Some clients would like to keep everything in their own hands and are therefore looking for extra design capacity (need: capacity driven). Other clients, however, do not want to keep everything in their own hands, but they still want to retain influence on the design (need: process control). Yet other clients want to develop an innovation or prefer a party which takes all responsibilities and deliver full service solutions. From this analyses, it appears that a layered structure can be discovered which ranks the different needs of the client. The needs are ordered from clients who want to control all the processes themselves (with the corresponding responsibilities) to clients who want to transfer responsibilities to their contractors instead of controlling all the processes themselves. The most far-reaching form is a client who prefers a full integrated solution.

Subsequently, the required tasks and associated competences to fulfill the different needs of the client are checked. In the research methodology a theoretical model is introduced which describes the different tasks needed to act as a systems integrator. The tasks are allocated to the different needs of the client in a way the tasks are logically required to meet the formulated clients' needs. For example, planning management and integral risk management are required to provide process control. Based on the results of two expert interviews among floor managers of Aveco de Bondt, it is determined to what extent the different tasks need to be fulfilled by the consultant himself or could be outsourced to fixed partners.

The underlined tasks are essential for developing into a systems integrator and therefore, knowledge and experience of these tasks is required. The tasks that are not underlined are less relevant for developing into a systems integrator and could therefore be outsourced to fixed partners within the network.

The different 'levels of involvement' are conditionally, which means that a consultant firstly has to fulfill the tasks and associated competences of level 1, before it can go to the next level. The level which a consultant will participate in, depends on the combination of product, market, technology and competences [9]. To be more specific, a systems integrator will provide some clients level 1 services and some clients services on another level. For example, clients who have a lot of knowledge, but not enough capacity. For other clients who are looking for specific innovative solutions, the systems integrator delivers integrated solutions on level 4 or 5.

The levels 1, 2 and 3 are project bounded, which means that these tasks need to be divided within the CB-team. The levels 4 and 5 are not project bounded, which means that these tasks are required to offer the client a better integrated full service solution at the project bounded levels 1, 2 or 3. Next, an explanation of the different 'levels of involvement' will be given.

Level 1: Capacity driven

Tasks and responsibilities are divided on the basis of required expertise to successfully execute the project and the available knowledge within a CB-team. The role of a consultant is mainly bringing in professional knowledge in the field of design and cost expertise.

Level 2: Process control

The client would like to keep processes in control. Achieving planning, managing risks, monitoring budget and managing quality are key processes which need to be managed. The role of the consultant is to facilitate and monitor the workflow by applying project, process and risk management.

Level 3: Taking responsibilities

Not all clients have the knowledge, resources, needs and / or capacity to manage the project themselves. Therefore, at this level, clients are looking for a party that takes control over the project on its behalf. The client would like to transfer tasks and responsibilities to the market, but at the same time wants the certainty that his demands, wishes and interests are properly represented within a CB-team. The consultant takes care of the daily management and coordination in a CB-team. Besides, the consultant provides stakeholder management and ensures that all parties have the right information.

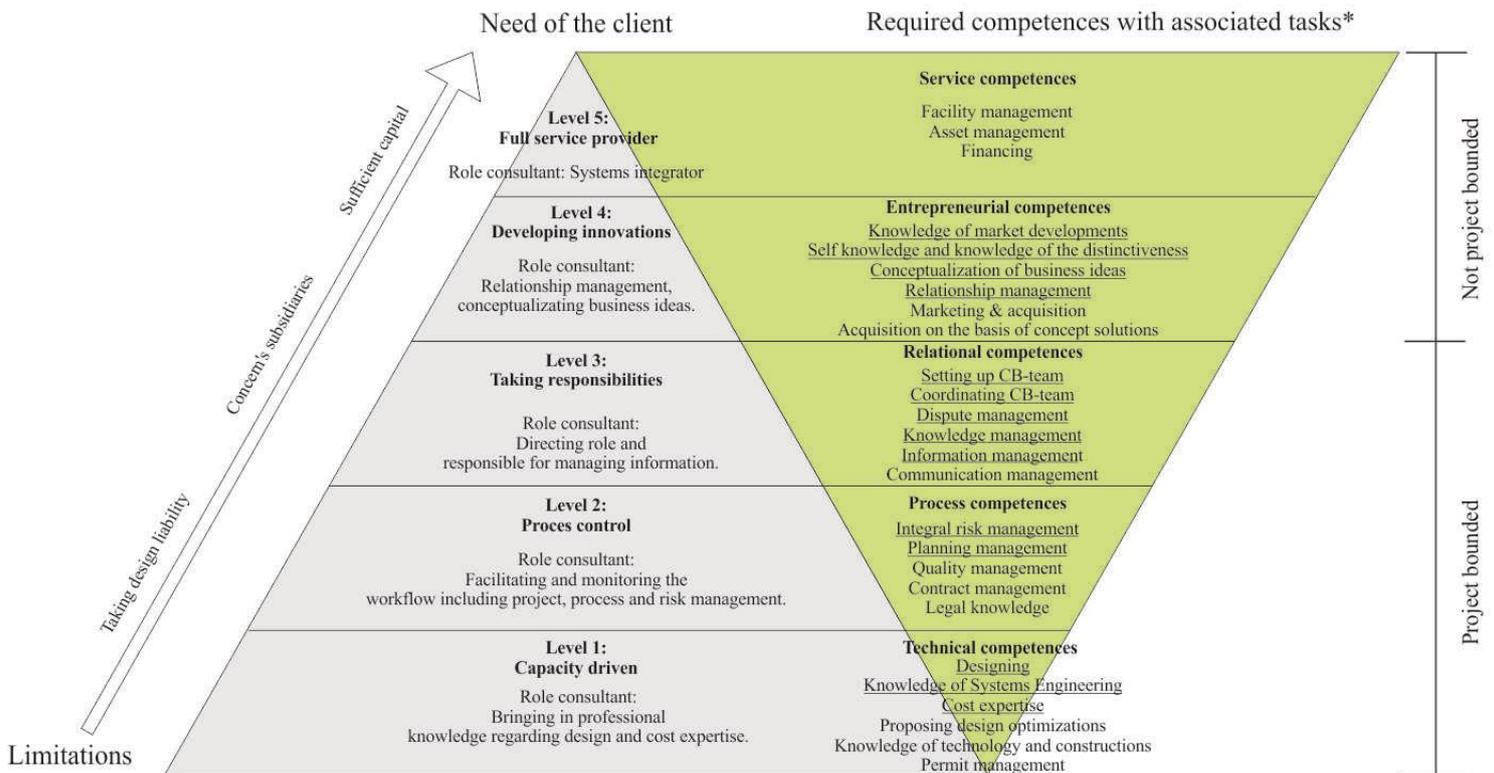
Level 4: Developing innovations

The client is faced with a problem and has the need to develop a product and / or process innovation. Developing innovations requires sharing and combining knowledge. The role of the consultant is to create a network of suppliers, (trade) contractors and knowledge institutes for developing smart solutions.

Level 5: Full service provider

The client is looking for a party that takes full contractual responsibility of the design, construction, maintenance, exploitation and financing of a building.

Figure 5 Levels of involvement



* Underlined: Tasks which need to be fulfilled by the consultant himself.
* Not underlined: Tasks which the consultant could outsource to fixed partners within the network.

6. Discussion and reflections

In this section, the results of this research are discussed. Furthermore, (1) three limitations which influence the possibilities for consultants to develop into a systems integrator are mentioned, (2) the contradiction between ‘CB-team’ and ‘systems integrator’ is described and (3) a reflection on participating in CB-teams; the first step to develop from capacity supplier to systems integrator is given.

Interpreting the results

In this research a case study consisting of semi structured interviews and a specially developed game was used. The 28 expert interviews were a mix of nine public clients, nine contractors, three project developers and seven people inside Aveco de Bondt. 28 expert interviews is a relatively small number, which might influence the validity of the games’ results. Still, the results of this case study give insights into the way tasks could be best divided between parties in CB-teams.

Table 2 displays the grouping of tasks in current CB-teams. This current research found that many tasks were perceived as collaborative tasks. These results are consistent with the characteristics of a CB-team mentioned by Pianoo (2017): ‘*working together in a collaborative manner with understanding for each other’s interests*’ [10]. Another important result was that the task of the consultant is limited to ‘designing’. This result is in agreement with findings of Boes (2017) and van Baal (2017), who mentioned that the role of the consultant is often passive and involves the elaboration of designs [3] [8].

Table 3 displays the grouping of tasks in the ideal CB-team. First of all, the results of this research indicate that clients and contractors have a different opinion about the ideal grouping of tasks. Secondly, contractors assigned more tasks to one party (even to themselves), though clients wanted to work more in a collaborative manner. These results are in line with the expectation that clients and contractors have a different view on the way in which tasks can be best divided. A possible explanation for this might be that the tendency of clients is dictated by the need for cooperation and management based on their responsibility as a client, though the tendency of contractors is based on cost control (progress) and risk distribution / control.

By comparing the current (table 2) CB-team and the ideal CB-team (table 3), it can be concluded that both models are mainly the same. Looking at the differences, one task is moved from the ‘client’ to ‘collaboratively’ and four extra tasks are assigned to the ‘consultant’, including ‘coordinating CB-team’. Respondents argue that the interests of the different parties are better served and that the blind spot is prevented, if an external party takes care of the process. These results are in accordance with recent studies indicating that governments are transferring more tasks and responsibilities to the market. It is therefore likely that this trend offers consultants the opportunity to take a more directing role in a CB-team [3] [8].

One should bear in mind that the grouping of tasks, as presented in table 2 & 3, is not a standard model. It differs for each CB-team which tasks are assigned to which party. The available knowledge

and capacity mainly determines the way tasks are assigned to parties.

One should also bear in mind that the case study mainly focused on public clients and did not focus on private clients. Besides, it is important to note that the results were obtained through a case study based on the Dutch collaboration model ‘CB-team’. A CB-team is characterized by some specific properties, as mentioned in the introduction of this paper. For this reason, no general conclusion can be made about the possibilities for engineering firms to develop into a systems integrator in other forms of cooperation.

Limitations which influence the possibilities for consultants to develop into a systems integrator

This research provides a model which describes the different steps consultants must take to develop from jobber to systems integrator. As mentioned by Dorée & Van der Veen (1999), control and knowledge about the design (present at consultants) are a crucial factor. However, it is not considered by Dorée & Van der Veen (1999) that consultants will develop into systems integrators, as consultants are limited in their (design) liabilities and often have insufficient capital. Therefore, some limitations must be mentioned which influence the possibilities for consultants to develop into a systems integrator.

First of all, it is unknown to what extent consultants are willing to abandon the limitations of their design liability. During the expert interviews different contractors emphasized that consultants should change their business model from a model based on ‘hours worked’ to participating in risk-bearing projects and therefore should abandon the limitations of their design liability.

Secondly, it is unknown to what extent consultants possess sufficient capital to offer integrated solutions as systems integrator. In contradiction to contractors most consultants have a business model based on ‘hours worked’, and therefore less available capital. For consultants which are part of a concern, it might be easier to gain sufficient capital. In general, a concern has a lot of experience in integrated contracts and has more available capital. This corresponds to Dorée & Van der Veen (1999), who described that contractors have experience with (1) the coordinating and leading role, (2) risk-bearing operations and (3) turnover power (capital) [28]. In addition to the first limitation, firms part of a concern could often be insured for higher values compared to general consultants [8]. This makes it easier for them to take design liability.

Thirdly, consultants which are part of a concern must mention another point of interest. In the current situation, consultants are often employed by one of the concern’s construction firms. If consultants enter the market as a systems integrator, they could become a competitor of subsidiaries of the concern. This requires a policy within the concern how to deal with these situations.

According to the mentioned limitations, it could seem obvious that contractors within the concern will take the role of a systems integrator, as they do not experience the mentioned limitations. In this situation the consultant of the concern could be better focusing on becoming a systems integrator of the internal organization.

The contradiction between ‘CB-team’ and ‘systems integrator’

One problem that emerged was the way the terms ‘CB-team’ and ‘systems integrator’ were connected in this research. The intention of this research was to gain more insight in the possibilities for Aveco de Bondt to develop from capacity supplier to systems integrator in CB-teams in the Dutch construction industry. Therefore, firstly this research started by providing insight into the way tasks are divided in the CB-team between client, contractor and consultant. Secondly, it showed which opportunities these grouping of tasks Aveco de Bondt offers to develop into a systems integrator. During this research, it became clear that the terms ‘CB-team’ and ‘systems integrator’ should not be directly integrated, as the fundamentals of both terms contradict each other. In table 3 an overview is given of the fundamental differences between a CB-team and a systems integrator.

Funda-mental differ-ences	CB-team	Systems Integrator
1	Project bounded (short term)	Not project bounded (business model, long term)
2	Consultancy role in a CB-team (limited liability)	Full contractual responsibility of the design and construction of the project (design liability).
3	Capacity supplier / Jobber	Specialized in a certain product / market / technology combination in which it offers total solutions.
4	All parties are equivalent in a CB-team.	The main contractor has the coordinating and leading role.
5	The company works together with changing partners within a CB-team.	The company works together with several fixed partners within a network.
6	The consultant is responsible for the processes (project integrating role)	The systems integrator is responsible for the end product.
7	Project are chosen based on the project specifications and required competences (short term)	Projects are chosen in the context of the chain (business model, sequential projects, learning curves)

Table 4 Fundamental differences between CB-team and Systems integrator [3] [9] [10] [16] [18] [21] [24]

The first difference is regarding short term thinking versus a long term business model. According to Principe (2003), Brusoni (2001) and Hobdey (2005), who distinguish two different analytical levels of systems integration, a CB-team is a type of static systems integration (project bounded) [23] [24] [25], though the objective of a systems integrator is a business model in which concepts are implemented in sequential projects (not project bounded) [18]. A second interesting difference is regarding the responsibilities and liabilities. A systems integrator has the full contractual responsibility of the design and construction of a project, though a consultant in a CB-team has a no or limited liability. Finally, in a CB-team all parties are equivalent, though a systems integrator is a main contractor who wants to control all the processes themselves. This result is in line with some expert interviews to which a model is presented in which many process related tasks were assigned to the consultant. The experts argued that the presented model did not agree with the CB-team fundamentals in which tasks are collaboratively fulfilled and decisions are collaboratively made.

To conclude, taking into account the fundamental differences between ‘CB-team’ and ‘systems integrator’, the consultant could take a more directing and leading role in CB-teams, however, it is not possible to be a systems integrator in CB-teams. The consultant might be an expert in CB-teams and could take an integrating role. Since the consultant does not have any contractual responsibility, the consultant is not a systems integrator. If the consultant has contractual responsibility and therefore takes a coordinating and leading role, it is not in a CB-team, as in CB-teams all parties are equivalent. To sum up, the terms ‘CB-team’ and ‘systems integrator’ must be kept separate.

Reflection: Participating in CB-teams; the first step to develop from capacity supplier to systems integrator.

The results of this research indicate that the consultant can take a more directing, coordinating and risk-bearing role in CB-teams. Taking a directing role in CB-teams could be the first step into the development of a systems integrator, as shown in figure 6. For example: the replacement of a roundabout. A consultant has already replaced several roundabouts according to a certain working method in a CB-team. Once the consultant has gained enough knowledge and experience with replacing roundabouts, he can decide to develop his own (improved) concept regarding the replacement of roundabouts. In this way, the consultant has specialized in a certain product / market technology in which it offers total solutions to the client.

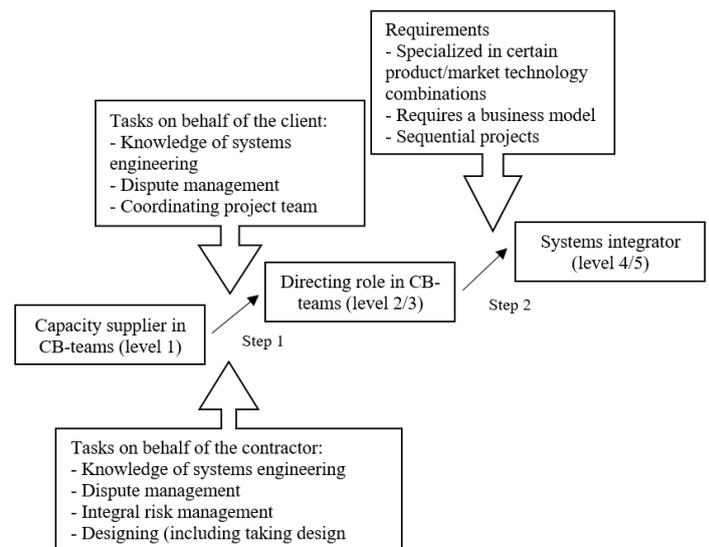


Figure 6 From capacity supplier to systems integrator.

To sum up, the following two options must be distinguished: (1) The consultant is part of the CB-team in which every party is equivalent and decisions are made collaboratively. The consultant fulfills a directing role which requires technical, process and/or relational related competences. (2) The consultant has specialized in a certain product / market technology in which it offers total solutions to the client. The consultant is functioning like a total contractor and takes design liability (systems integrator).

7. Conclusions

General conclusions - In general, the analysis of the case study's results show that consultants can move away from its consultancy role and can take a more directing, coordinating and risk-bearing role. It depends on the type of client and client's needs to what extent consultants can take this role. Furthermore, this research concludes that becoming a systems integrator in CB-teams is a step too far, especially in the public market. Some thresholds will have to be removed by the consultant such as the willingness of consultants to abandon the limitations of their design liability, contractors who process themselves to be the 'central' party in the process and the traditional attitude of public clients.

Another interesting conclusion is that the needs of the clients, as mentioned in figure 5, differ for each type of client and type of organization. Clients with a lot of in-house knowledge have other needs related to clients with less in-house knowledge. Besides, the needs of the client could differ for each project, dependent on the objective of the project. The available knowledge and capacity even determines the needs of the client.

The intention of this research was to gain more insight in the possibilities for Aveco de Bondt to develop from capacity supplier to systems integrator in CB-teams in the Dutch construction industry. It is investigated to what extent both terms could be integrated. During this research, it became clear that the terms 'CB-team' and 'systems integrator' should not be directly integrated, as the fundamentals (as shown in table 4) of both terms contradict each other. A CB-team is project bounded (short term) and in a CB-team all parties are equivalent whereas acting like a systems integrator requires a business model (long term) and taking full contractual responsibility. Therefore, this research concludes that it is not possible to become a systems integrator in CB-teams.

Furthermore, this research shows that participating in CB-teams could be the first step to develop from capacity supplier to systems integrator. Once the consultant has gained enough knowledge and experience with regard to a specific domain, he can decide to develop his own (improved) concept. In this way, the consultant has specialized in a certain product / market technology in which it offers total solutions to the client.

Implications for science - Previous research has established that mainly contractors will fulfill a role as a systems integrator, as they have experience with (1) the coordinating and leading role, (2) risk-bearing operations and (3) turnover power (capital). However, there are relatively few historical studies about the possibilities for consultants to develop into a systems integrator. This research provides more insights in the different roles a consultant could take to develop from capacity supplier to a systems integrator.

Contributions to practice - The developed model 'Levels of involvement' will help consultants to determine at which level they want to enter different projects. Subsequently, the model shows which competences the consultant needs to develop. Furthermore, the developed game is very useful to create more awareness of each other's interest, qualities and competences. The game will help to make better and clearer decisions during the Project Start Up (PSU) between client, consultant and contractor about the grouping of tasks in the CB-team.

Recommendations - Consultants who want to move away from its consultancy role and want to take a more directing, coordinating and risk-bearing role, are recommended to make use of the developed model. The model describes the different steps consultants should take to develop from a capacity supplier to a systems integrator. Important conditions consultants need to take into account are: (1) to what extent are they willing to abandon the limitations of their design liability, (2) do they have sufficient capital (the condition for offering integrated solutions as systems integrator) and (3) if they are part of a concern, do they become a competitor of subsidiaries.

Given the reform initiatives in the construction industry and the emergence of integrated contracts, consultants should consider taking a role as systems integrator as a strategic choice. It should be examined to what extent this development fits within the long-term vision of a company, and if the company has sufficient capital. After all, sufficient capital is required to offer risk-bearing integrated solutions.

For anyone who wants to use this papers' proposed framework, it is important to note that this framework is based on the Dutch collaboration model 'CB-team'. Future research should therefore focus on the application of this framework in other forms of collaboration in the construction industry.

8. References

- [1] A.G. Dorée, "Collusion in the Dutch construction industry: an industrial organization perspective.," Building research and information, 2004.
- [2] Rijkswaterstaat, 2017. Available from <https://www.rijkswaterstaat.nl/over-ons/nieuws/nieuwsarchief/p2015/04/Project-DOEN-meer-bereiken-met-minder-regels.aspx>.
- [3] H. Boes. Interview, 18 oktober 2017.
- [4] J. H. Dronkers, "Voor Rijkswaterstaat is co-creatie de toekomst," *Cobouw*, p. 13, 2013.
- [5] Marktvisie, 2016. Available from www.marktvisie.nl
- [6] Cobouw, 2012. Available from: <https://www.cobouw.nl/bouwbreed/nieuws/2012/01/marktinitiatieven-zijn-harder-nodig-dan-ooit-101136581>.
- [7] M. Kloosterboer, "Control of client-contractor cooperation.," 2017.
- [8] M. van Baal, Interview, 31 juli 2017.
- [9] A.G. Dorée, Interview, 21 december 2017.
- [10] Pianoo, "Traditionele contractvormen GWW (RAW, OMOP en Bouwteam)," 2017. Available from: <https://www.pianoo.nl/markten/gww/inkopen-gww/gww-contractvormen/traditionele-contractvormen-gww-raw-omop-bouwteam>.
- [11] L. Song, Y. Mohamed, and S. M. AbouRizk, "Early Contractor Involvement in Design and Its Impact on Construction Schedule Performance," *J. Manag. Eng.*, vol. 25, no. 1, pp. 12–20, Jan. 2009.
- [12] M.M. Rahman & Alhassan, A, 'A contractor's perception on Early Contractor Involvement', *Built Environment Project and Asset Management*, vol. 2, no. 2, pp. 1-2012
- [13] A.P.C. Chan, Chan, DWM & Ho, KSK, 'An empirical study of the benefits of construction partnering in Hong Kong', *Construction Management and Economics*, vol. 21, no. 5, pp. 523-33. Cohen, J 2010, *Integrated Project Delivery: Case Studies*, American Institute of Architects (AIA) - AIA California Council, Sacramento, CA. Dal, 2003
- [14] F. Rahmani, M. M. A. Khalfan, and T. Maqsood, "The use of early contractor involvement in different countries." 2014.
- [15] L. a. Myers, "Public investment management in the new EU member states: strengthening planning and implementation of transport infrastructure investments," 2009.
- [16] Bouwend-Nederland, "Bouwteam samenwerkingsvorm," 2018. Available from: <http://www.bouwendnederland.nl/praktijkinformatie/bouwteam>.
- [17] M. Swainston, 'Early Contractor Involvement', *Queensland Roads Technical Journal*, vol. Edition 2, 2006
- [18] M. E. J. Rutten, A. G. Dorée, and J. I. M. Halman, "Innovation and interorganizational cooperation: a synthesis of literature," *Constr. Innov.*, vol. 9, no. 3, pp. 285–297, Jul. 2009.
- [19] A. Dubois and L.-E. Gadde, "The construction industry as a loosely coupled system: implications for productivity and innovation," *Constr. Manag. Econ.*, vol. 20, no. 7, pp. 621–631, Oct. 2002.
- [20] G. Winch, "Zephyrs of creative destruction: understanding the management of innovation in construction," *Build. Res. Inf.*, vol. 26, no. 5, pp. 268–279, Sep. 1998.
- [21] A. Davies, T. Brady, and M. Hobday, "Organizing for solutions: Systems seller vs. systems integrator," *Ind. Mark. Manag.*, vol. 36, no. 2, pp. 183–193, Feb. 2007.
- [22] R. Miller, M. Hobday, T. Leroud-demers and X. Olleros, "Innovation in Complex Systems Industries: the Case of Flight Simulation," *Ind. Corp. Chang.*, vol. 4, no. 2, pp. 363–400, 1995.a
- [23] A.D. Principe, "The business of systems integration.," Oxford: Oxford University Press, 2003.
- [24] M. Hobday, A. Davies, and A. Principe, "Systems integration: a core capability of the modern corporation," *Ind. Corp. Chang.*, vol. 14, no. 6, pp. 1109–1143, Aug. 2005.
- [25] S. Brusoni, A. Principe, "Knowledge specialization, organizational coupling, and the boundaries of the firm: Why do firms more than they make?," *Administrative Science Quarterly*, Vol. 46, No 4, 597-621, 2001.
- [26] T.D.A. Brady, "Can integrated solutions business models work in construction?," *Building Research & Information*, 33 (6), 571-579, 2005.
- [27] G. Dosi, M. Hobday, L. Marengo and A. Principe "The economics of system integration: Toward an evolutionary interpretation.," *Laboratory of Economics and Management*, 2002.
- [28] A. G. Dorée and B. van der. Veen, *Strategische allianties in de bouw : van hooggespannen verwachtingen naar concrete actie?! UT*, 1999.
- [29] Fluor, 2018. Available from: <http://www.fluor.com/netherlands>.
- [30] S. van de Horst, "De architect als systems inyegrator: Een casestudie hoe een architectenbureau kan optreden als centrale partij in het Nederlandse bouwproces.," 2010.
- [31] W.B. E. Bonhof, "Geïntegreerd ondernemen als systems integrator," 2008.
- [32] Piramide van Maslow, 2018. Available from: https://nl.wikipedia.org/wiki/Piramide_van_Maslow.