A supply-driven construction industry for transportation infrastructure

New opportunities for consulting engineers

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Preface

“A journey of a thousand miles begins with a single step”

Confucius (551BC – 479BC)

This report is the result of my Master of Science (MSc) graduation thesis project carried out at DHV head-office in Amersfoort. This project is the final part of the two-year MSc programme Transport, Infrastructure and Logistics (TIL) at Delft University of Technology. Through elective courses and other elective courses within the masters programme, I have specialized myself in the field of transport, infrastructure and logistics with a focus on strategic management and supply chain management. This report marks the end of a period as student of Delft University of Technology and the start of a professional career as a TIL engineer.

In the past two years, I have really enjoyed the possibility to customize the TIL programme according to my individual preferences. Since I am convinced that there is an increasing need for integration of concepts, theories and disciplines, it was a great opportunity for me to participate in courses, and meet students and academic members, at three faculties. Looking back, I feel this two-year TIL programme was satisfying. However, at times I missed the participation and appealing contributions of professors of the three participating faculties/sections, representing the TIL character.

Since I am very interested in large transportation infrastructure projects, I am thankful of DHV for giving me the opportunity to do my graduation project at this company. I consider DHV a broad and multidisciplinary organization, participating in interesting projects at both the clients’ side as well as the contractors’ side. As stated in the title, the aim of this research is to give a view on a supply-driven construction industry for transportation infrastructure with an emphasis on the positioning of DHV. This research topic enabled me to combine my background education of technology, policy and management in a civil engineering context.

One of my motives for choosing this research topic is the increasing complexity and dynamics of large infrastructure projects. Many of these projects attract much attention, because they involve a lot of public money. As I have come to realize that the structure of the industry and forms of procurement may be largely contributing to the many budget- and time overruns in these projects, it was a challenge for me to explore an alternative view on the construction industry.

At times, the process dynamics of this graduation thesis have put some extra pressure on me, especially looking at the acceptance of the composition of my graduation committee. Nevertheless, I am relieved that these issues have come to a satisfying solution in the end. My warm thanks go to my supervisors at Delft University of Technology, being Prof.dr.ir. H.A.J. de Ridder, Prof.dr. G.P. van Wee, ir. R. Vrijhoef and dr. J.F.M. Koppenjan. Essential to come to this final report were their critical feedback on my work when necessary together with their support and advice in our sessions during the research.

Furthermore, I would like to thank DHV and especially Carlo Kuiper for providing me the opportunity and freedom to perform the research at their company. The enthusiasm for my research topic and the willingness to participate in interviews and the questionnaire survey shows a positive attitude of DHV and its employees. Last but certainly not least, I thank my family and girlfriend Esther for their everlasting support.

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A supply-driven construction industry for transportation infrastructure

Executive summary

Introduction
The construction industry faces some important criticism regarding budget and time overruns, lack of innovation, lack of quality, lack of end-user focus, lack of standardisation, lack of supply chain integration, fragmentation of the industry, fraud and adversarial behaviour. The structure of the industry does not appear to be fit for dealing with increasing dynamics and complexity, changing perceptions, changing requirements, changing wishes and customer satisfaction.

Several renewal initiatives have been taken in order to resolve the problems and gain higher efficiency and innovation. Although a lot of experience is gained nowadays with integrated contracts like design-build, design-build + finance, maintenance or operation, and public-private partnerships, the outcomes and evaluations of these projects still often show poor or marginal performance, like for instance the high-speed rail link from Amsterdam to Brussels.

Research objective
As the traditional demand-driven construction industry is currently changing, several trends point in the direction of an alternative construction industry that is supply driven. A supply-driven construction industry implies a radical change from a responsive pull market to a proactive push market. Since a supply-driven construction industry has important implications for the business operations and environment of consulting engineers like DHV, the aim of this research is to give a view on the possible future positions of consulting engineers and specifically DHV in a supply-driven construction industry along with the corresponding strategic requirements for these positions.

Research approach
This research consists of three parts, being the current situation in construction (demand-driven), the future situation in construction (supply-driven), and the future positioning of DHV. The first and second part of the research rely mainly on literature research and interviews. For the third part of the research, a management questionnaire survey is designed after which the opinions of 27 managers at DHV are investigated. The research concludes with a discussion about future strategies for achieving any of the possible future positioning options for DHV. For this final discussion, an interview with managing director at DHV Vic Prins is also used as input.

Peculiarities of construction
Since the construction industry is different from most other industries, the five most important peculiarities found in construction are:

- One-of-a-kind nature of construction projects (resembling prototypes)
- On-site production
- Temporary and ad-hoc organizations
- Demand-driven construction process (close to full customization)
- Fragmented in terms of the number of enterprises, involvement of different parties with different disciplines in different project phases

Increasing complexity and dynamics in construction
The construction industry faces a situation and context with increasing complexity and dynamics. Several factors are contributing to the complexity and dynamics resulting in more uncertainty and hampered control, especially looking at large infrastructure projects. These factors include technological developments, technological interfaces, social interfaces, complex planning procedures, large-scale endeavors and the ambiguity on the distribution of risks and responsibilities. In addition, there is an increasing pressure on the construction industry to contribute efficiently and effectively to complex societal issues like mobility, sustainable developments and quality of life.
Recognition of the need to change
An important driver for change in the construction industry is the recognition of the need to change. This recognition is reinforced by the continuous budget and time overruns, limited efficiency, limited innovation, fraud and adversarial relationships in the construction industry. In the Netherlands, this recognition is expressed by renewal initiatives such as ‘Regieraad Bouw’ and ‘PSIBouw’, alike the program ‘rethinking construction’ (‘construction excellence’) in the UK.

Public clients return to the core business leaving a gap
In addition, (public) clients like the Dutch government agency for transport, public works and water management ‘Rijkswaterstaat’, aim to return to the core business and thereby increasingly transfer activities to the contractors’ side. Consultancy and engineering firms that are traditionally the ‘right hand’ of the client, now increasingly have the opportunity to work at the contractors’ side.

New procurement methods and integrated contracts
A consequence of the recognition of the need to change and the altered role of (public) clients is the development of new procurement methods to overcome the inherent weaknesses of the traditional procurement model design-bid-build. The traditional procurement model is characterized by a high level of customization, a separation between design and realization phases and a rather static construction process. New methods of procurement focus on integration of the processes: program, design, realization, operation and maintenance. This trend reinforces forward and backward integration of several actors involved. For instance, contractors who traditionally only focused on the construction process are now also involved in the design, engineering or maintenance processes.

In the traditional procurement model the construction object is fixed in terms of full specifications that are put out to tender and as a result there is little opportunity to make strategic trade-offs, innovate and perform activities differently than the competitors. Now that clients aim to exploit more of the knowledge and expertise at the market and contractors or consortia are involved in an earlier stage of the construction process, the involvement of contractors or consortia is more integrated with more opportunity to innovate and do proposals. However, currently the withdrawal of Rijkswaterstaat in the Netherlands, expressed by less client interference and specifications that are more functional, still hampers. Moreover, also contractors and consulting engineers are struggling with new forms of collaboration and changing business strategies.

Less client interference and more room for innovation in the market
The trends in a changing construction industry point out that the procurement model is changing from a demand-driven and fragmented process towards a supply-driven and integrated process. Integrated contracts put more authority, control and responsibilities at the market. Whereas in the demand-driven construction industry supply follows demand, in the supply-driven construction industry demand follows supply.

From a responsive pull market to a proactive push market
In the supply-driven construction industry, a responsive pull market with a high level of client interference is replaced by a proactive push market with less client interference. From a conceptual perspective, a supply-driven construction industry implies that concepts or designs are less client-specific and more pre-engineered. Figure A represents the change from the traditional demand-driven industry to the supply-driven industry. The right triangle in the figure indicates that only a small share of pre-contractual tender work is needed in an early project phase. Suppliers already have virtually pre-engineered product families which can be made client-specific in accordance with specific wishes and requirements. Several variables could be altered in order to customize conceptually standardized products.
New positions for consulting engineers

Figure B shows that for consultancy and engineering firms like DHV, there are several opportunities and different positioning options in a future supply-driven construction industry. Consulting engineers could choose for a responsive position delivering expertise wherever needed or for a proactive position as developer, innovator or intermediary (systems integrator). Furthermore, consulting engineers could choose to work either at the clients’ side or at the contractors’ side.

High expectations for positions 3 and 4

The results of the DHV-management questionnaire survey in the third part of the research, show high expectations for position 3 and position 4. Besides skills and knowledge of multidisciplinary problems and networking, the intermediary role in position 3 requires an organization that is able to deliver value added by integrating client demand and market supply proactively. The developing or partnering role in position 4 requires skills and knowledge in risk management, multidisciplinary problems, strategic partnering, entrepreneurship and a business orientation. Both positions 3 and 4 require an organization that is proactively exploiting its capabilities (inside-out) instead of positions 1 and 2 who require an organization that is responding to market needs (outside-in).
Position 1, position 3 and position 4 are desired according to DHV managers, but if they would have to choose for only one position, 52% of the managers would choose for position 4 while only 11% and 7% would choose for positions 1 and 2 respectively (figure C). Positions 3 and 4 also show the highest expected profitability for DHV in a future supply-driven construction industry. Position 2 shows the lowest expectations on profitability and is also least desired and least preferred.

DHV as leading integrator or developing innovator

Altogether, the perspective of a supply-driven construction industry offers good opportunities for DHV. From the perspective that the market share of activities at the contractors’ side is growing and the market share of activities at the clients’ side is shrinking, position 4 has much potential for DHV. On the other hand, among others the interviewed managing director at DHV expects that this trend is only weak in the near future. DHV managers expect the largest organizational change for position 4, while position 3 shows a good match with the current capabilities of DHV since DHV traditionally focuses on the client side.

This indicates that position 3 is a feasible and preferred position and matches the expectations on the near future. Therefore, the primary focus on the short and middle term should be to make a change from position 1 to position 3 at the client side. DHV should take an intermediary role for clients as a leading integrator. With its two-sided knowledge and expertise, DHV must be able to look proactively for integration of demand and supply. It should proactively link appropriate solutions, technologies, or processes to problems and issues of (public) clients.

On the other hand, position 4 shows also good expectations according to DHV managers. Since DHV managers do not expect the supply-driven model to be dominant in the near future and currently has too few commercial entrepreneurs and business oriented employees, position 4 is a good positioning option for a long-term strategy. Especially looking at trends like supply chain integration, integrated procurement and more unsolicited proposals, the industry is no longer characterized by fragmentation and outsourcing but instead by integration and partnering. When choosing for strategic partnering, DHV will face complications with its current status of being an independent consulting engineer.

Recommendations

Recommendations for DHV are to aim for a more proactive attitude and encouragement of innovative entrepreneurship. A stronger focus on the internal strengths could help to exploit the internal capabilities. An integrated vision from inside out on several societal and environmental issues like climate change, sustainability, transportation, mobility etc. would help to become more proactive. A shift from effort-based obligations towards result-based obligations would express more innovative
entrepreneurship. Furthermore, clearly, DHV should avoid a subcontracting role when working at the contractors’ side. Instead, DHV should aim for a partnering or leading position in the industry. Again, innovative entrepreneurship would help to become a stronger partner for the contractors’ side.

Expectedly, an increasing number of providers of integrated total solutions operate at the supply side. Corresponding to the trends of more supply chain integration and integrated procurement, these providers of total solution are represented by one focal point taking overall responsibility. From the perspective of the supply-driven construction industry in this study, consulting engineers can gain a great competitive advantage in long-term relationships with partners. This would enable more proactive concept/product development, innovation, shared learning, repetition of concepts/products, continuous improvement and potentially higher profits.

Taking the lead and daring the risk
This study reveals that a strong position for DHV in the near future would be a position as clients’ intermediary, proactively integrating demand and supply. On the long-term, a partnering or leading position at the contractors’ side shows strong prospects. For both strategies, it is up for DHV to take the lead and dare the risk.
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1. **Introduction**

As in all countries, the building and construction sector is a significant contributor to the Dutch economy. With an annual turnover of approximately € 65 billion, the sector represents 7% of GNP (CBS, 2006). With a share equivalent to roughly 17%, the civil engineering sub-sector realises an annual turnover of more than € 10 billion in the Netherlands. The main clients of civil engineering works are public authorities who perceive a need to invest in these projects in order to meet the needs of the public (taxpayers). With a yearly budget of approximately € 5 billion, the most important Dutch public client in the civil engineering industry is the government agency for transport, public works and water management named Rijkswaterstaat. Another important client with an annual budget of approximately € 2 billion is the Dutch infra-manager for railways, named ProRail.

The construction industry is often criticised for not achieving the level of performance and productivity shown by other industrial sectors. There are many reasons for this but one of the most striking reasons are the budget and planning overruns of large infrastructure projects (Morris & Hough, 1987). A typical example of such problems is the delayed completion date of probably more than 10 months of the Dutch High Speed Rail Link (HSL) between Amsterdam and Paris, causing an estimated budget overrun of € 222 million (Cobouw, 2007). Other points of criticism directed at the construction industry are lack of innovation, lack of quality, lack of focus on customer or end-user, lack of standardisation, lack of supply chain integration, fragmentation of the industry, fraud and adversarial behaviour (Pries & Doreé, 2005; Wong & Fung, 1999).

In 1994 an influential report 'Constructing the team' was written by Sir Michael Latham who reviewed the procurement and contractual arrangements in the UK construction industry (Latham, 1994). One of the first responses to the recognition of the poor performance of the construction industry in the UK was the 'Construction Task Force', which was commissioned by the deputy Prime Minister John Prescott to assess the quality and efficiency of the UK construction industry. This reform programme led by Sir John Egan resulted in 1998 in a report with recommendations named ‘Rethinking Construction’ (Egan, 1998).

Also in the Netherlands several initiatives have been taken after the parliamentary inquiry and audit commission for the construction industry (Vos-committee) in 2002 and the temporary parliamentary infrastructure committee (Duivesteijn-committee) in 2004. In response to the recognition in the Netherlands that many problems are caused by the structure of the construction industry, the construction reform council (Regieraad Bouw) was commissioned by three ministries. Inspired by the UK programme ‘Rethinking Construction’, this new council aims at structural reforms in the Dutch construction industry.

Private parties in the construction industry took another initiative with the programme for change under the title of ‘Process Innovation in Building and Construction’ (PSIBouw). The ‘Construction Task Force’ in the UK and ‘Regieraad Bouw’ and ‘PSIBouw’ in the Netherlands have initiated and accelerated a reform process or transition phase from a demand-driven, fragmented, inward looking construction industry towards more process integration, early involvement of private parties, unsolicited proposals, lifecycle perspective and focus on the final customer. This transition implies changing roles, responsibilities and strategies for all the parties in the supply chain of construction projects. In figure 1.1, a simplified representation of the traditional construction industry is presented. Consulting engineers are architects, engineering and consultancy companies.

This research is conducted at DHV consultancy and engineering which is represented in figure 1.1 as a consulting engineer for the (public) client of the construction project. Traditionally firms like DHV only

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1 In Dutch GWW: Grond- Weg en Waterbouw.
2 See glossary in appendix G for alternative terms.
3 Ministeries EZ, VROM en V&W.
4 Nowadays: Construction Excellence.
had a contractual relation with the (public) client, but since more integrated contracts are being used, consultancy and engineering firms also execute tasks for contractors.

DHV is an international consultancy and engineering company employing around 4000 people, operating from about 60 cities in almost 30 countries. DHV conducts activities in the areas of transport, infrastructure, water, environment, spatial planning, agriculture, industrial accommodation and real estate. DHV offers a broad range of services in these areas, from strategic consultancy, policy analysis, research and feasibility studies to design and engineering, project management, operational management, general contracting and organizational development. DHV ranks third among the consultancy and engineering firms in the Netherlands, 19th among the consultancy and engineering firms in Europe and 39th among the international design firms in the global consultancy and engineering market (DHV, 2005).

1.1 Problem description

Some important criticism regarding the construction industry was already mentioned like budget- and time overruns, lack of innovation, lack of quality, lack of focus on customer or end-user, lack of standardisation, lack of supply chain integration, fragmentation of the industry, fraud and adversarial behaviour. The structure of the construction industry appears to be not fit for dealing with increasing dynamics (uncertainty in time), complexity (technological, managerial and social), changing perceptions, changing requirements, changing wishes and customer satisfaction.

Several renewal initiatives have been taken in order to resolve the problems and gain higher efficiency and innovation. The absence of a uniform underlying theory of construction seems to have resulted in renewal initiatives from different underlying (partial) perspectives and on different levels like operational, tactical and strategic levels. For instance, project management approaches try to control the inherent dynamics in construction by means of clear work breakdown structures, clear task responsibilities, but also with use of stochastics and simulation tools in budgeting, planning and risk management (Miller & Lessard, 2000). A more managerial and strategic approach to increase the performance of this industry is to use devices like integrated contracts (forward and backward integration) so the effectiveness and efficiency of the construction process can be increased.

Although nowadays a lot of experience is gained with integrated contracts like design-build, design-build-maintain, design-build-finance-maintain, and public-private partnerships, outcomes and evaluations of these projects still often show poor or marginal performance. Therefore, an integrated vision, named ‘the Living Building Concept’ has been developed as an orientation to make a fundamental revolutionary change in the way of working in the construction industry (De Ridder, 2006). The construction industry has to become more like normal industries that are supply-driven, end-user oriented with creativity and initiative at the market.
Some small steps towards this new construction process have taken place in the Netherlands where public client Rijkswaterstaat has taken a new business strategy. This redefinition of their core business has the objective of acting as network manager in the future. This means increasingly making use of the knowledge, expertise and creativity at the market as a professional client. They will no longer specify solutions, but instead outline the solution space. The market (contractors, suppliers, consulting engineers) are increasingly allowed and asked to design solutions and come up with unsolicited proposals.

This revolutionary change in the construction process will have important consequences for consultancy and engineering firms like DHV in the Netherlands. In this transition phase DHV is likely to be confronted with changing tasks, responsibilities, opportunities and threats. For DHV it is important to know the consequences of the new supply-driven construction industry for their current business functions and consequently the opportunities to reposition themselves either reactively or preferably proactively.

1.2 Aim of the research
Starting point of this research is the current situation in the construction industry and in particular large transportation infrastructure projects. The assumption is made that eventually the construction industry will change from demand-driven to supply-driven. The focus of the research is not on the question when the industry will become supply-driven. Instead, emphasis is put on the consequences of a supply-driven industry and changing positions of the parties involved. Consequently, this research can help DHV to become more adaptable by enabling them to first recognising change and using this creatively to its advantage. Therefore, the objective of this research is as follows:

The aim of this study is to give a view on the possible future positions of DHV in a supply-driven construction industry along with the corresponding strategic requirements for these positions.

1.3 Research questions
To achieve the research objective as described in paragraph 1.2, the main research question is stated as follows:

What are the drivers, consequences and opportunities of the transition to a supply-driven end-user oriented construction industry for consultancy and engineering companies? And what role, positioning and strategy are most fit for DHV in a future supply-driven construction industry?

The main research question can be decomposed into five sub-questions. The first one puts emphasis on the current construction industry and trends. The second one focuses on how the future supply-driven construction industry is organised. Furthermore, the third sub-question investigates the consequences of the supply-driven industry for the consultancy and engineering sector in general. Then the fourth sub-question investigates what position and role fits DHV best. The last sub-question investigates how the altered role and position might be achieved. Underneath, the five research sub-questions are presented:

1) How is the construction industry currently organised and what trends can be identified, in particular for transportation infrastructure?

2) How will the future supply-driven construction industry be organised?

3) What consequences in terms of changing positions and roles can be identified for the consultancy and engineering sector?

4) What position and role in a supply-driven construction industry fits DHV best?

5) How can the new industry position for DHV be achieved?
1.4 Research approach

As presented in figure 1.4, this MSc. graduation project is divided into three phases. The first phase focuses on the current situation in construction (‘as is’). The second phase focuses on a future supply-driven construction industry (‘to be’). After this, the third phase will focus on how DHV can best position itself with the corresponding strategies for that position (‘how-to’).

The approach that is used in this research is what Van Aken (2005) describes as prescriptive (design science) or solution-oriented management research. He distinguishes between ‘Mode 1 knowledge production’, being purely academic and mono-disciplinary, while ‘Mode 2 knowledge production’ is multidisciplinary and aims at solving complex and relevant field problems. This research approach is based on ‘Mode 2 knowledge production’ as various theories are used to design and explain a future situation and consequently empirically test this future situation in terms of strategic requirements for DHV. Therefore, this research approach is multidisciplinary and solution-oriented, and aims to solve the problems in construction as explained in paragraph 1.1.

In the first phase, a description of the current situation in the construction industry is made. First, a characterisation of the construction industry is made. Then, the past and current forms of procurement are explained. After this, the most important trends in construction are discussed. It is important to understand the structural features of the construction industry, the context and the factors driving structural changes. In this phase, a lot of international literature is reviewed and especially construction management research in the period after the Latham report in the UK in 1994. Besides the literature review which enables to take an international perspective, also several interviews at DHV are used, taking a broad perspective in order deepen the understanding of the Dutch construction industry and the most relevant problems for the Dutch construction industry.

The second phase explains several theories that are used to explain the future supply-driven construction industry. These theories involve production-based construction theory, economics-based construction theory, organization theory, theory on competitive advantage and strategy, and the ‘Living Building Concept’. These theories are very useful as structural changes in the industry will clearly have its impact on the organization of projects, the internal organization of actors involved, the interaction between actors involved, the competitive behaviour and strategic trade-offs. For instance, an outsourcing supply chain is organised quite differently than a partnering supply chain, or demand-driven supply requires different business strategies than supply-driven demand.

Furthermore, in this phase the future supply-driven market situation is described based on these theoretical explorations. Consequently, the way in which the consultancy and engineering sector is likely to be affected and the roles and repositioning that might be needed in this future situation, are also investigated. In addition, four possible future positions are briefly described in terms of skills, knowledge, type of employees, type of organization and competitive trade-offs needed for those positions.

The schematization of these four positions is based the two most important factors determining the strategic position of DHV with respects to this study, namely working for clients or contractors or working responsively or proactively. This schematization is validated through several interviews at DHV. Some participants understood and agreed with this schematization, while others proposed slight changes or had a slightly different perspective on the positioning options. The schematization that is used in this research reflects four possible positions that are commonly understood at DHV.

The third phase emphasizes on DHV’s future positioning and therefore this part might become (partially) classified. A questionnaire survey is conducted at DHV and focuses on middle and higher management positions in this organisation. This questionnaire survey investigates DHV management opinions regarding the positioning of DHV in a future supply-driven construction industry. The first part of the questionnaire puts emphasis on the general requirements to operate in one of the future positions. The second part aims at the situation of DHV in one of those future positions in terms of strengths, weaknesses, opportunities and threats. The last part of the questionnaire focused on the preferences and expectations in terms of the expected profitability, the desirability and the most
preferred future position. The questionnaire survey is conducted through the web-based application ‘Netquestionnaire’. Before the final questionnaire survey was distributed at DHV, the questionnaire was first tested with two employees of DHV. The feedback from this testing was very helpful to construct a questionnaire that could easily be understood by the respondents of the survey.

A questionnaire survey is chosen as an appropriate research method in order to achieve a statistical valid sample exploring the opinions and expectations of managers at consultancy and engineering firm DHV. Also a sector-wide questionnaire survey was taken into consideration but was judged infeasible with respect to the planning of this graduation project. The questionnaire included a set of questions that are repeatedly used for all four positions in order to perform a sound comparison between the four positions. The answering options for these questions are partly based on preset answers and partly based on open answers. This approach is chosen in order to enable respondents to state self-defined answers to the questions. It is considered that the opportunity for respondents to add self-defined answers would also increase the validity of this research approach.

After the data analysis of the questionnaire results, the empirical results from the questionnaire survey are confronted with the theoretical findings and expectations of phases 1 and 2. A SWOT analysis is used to identify what might be a promising position for DHV. The required future capabilities are confronted with the strengths and weaknesses of DHV. As input for the discussion, the expectations and preferences of DHV’s management combined with a final interview with a managing director of DHV are used.

In the final interview, a managing director is confronted with the results from the questionnaire survey together with other results of the research. A colleague at DHV assisted in this interview writing down the minutes of the topics discussed. As a managing director has a leading position in the strategic decision-making at DHV, it is considered that the research findings would be more valid if these are presented and discussed with a managing director. Finally, after the discussion of the results, the conclusions and recommendations are drawn.
A supply-driven construction industry for transportation infrastructure

Figure 1.4: Research model.
1.5 Research scope

In this paragraph, some assumptions are explained in order to limit the scope of this research. First, as presented in figure 1.5, the focus of this research is not on policy processes that determine what large infrastructure projects are built. Instead, the focus of this research is on the structure of the industry, the strategic management and supply chain management. This means that the way in which the construction industry is organised and supply chain actors cooperate are the central issues in this research.

![Policy processes diagram]

As mentioned before, this research assumes that the construction industry will change from its current state, which is demand-driven, towards a supply-driven construction industry. It is unknown whether this transition process will be rapid or slow, linear or exponential, continuous or discrete, but since it is assumed in this research that this ‘scenario’ will take place, it is important to know what the consequences are for DHV.

In addition, a focus is put on large transportation infrastructure projects in civil engineering like bridges, tunnels, freeways, waterways, railways etc. contracted by public authorities. The contracting authorities (public clients) of infrastructure projects are obliged to adopt European-tendering rules. According to European directive 2004/18/EC the threshold amount for these rules is set at €5,278,000 for public works. Furthermore, these projects must enact an environmental impact assessment (EIA) procedure.

Since most large infrastructural projects in the Netherlands are contracted out by the government agency for transport, public works and water management (Rijkswaterstaat), emphasis is put on this public authority for investigating the roles and interests of important actors. Furthermore, Rijkswaterstaat is considered a very important client for DHV Amersfoort, because DHV has been and still is involved in many Rijkswaterstaat projects.
1.6 Report outline

After the introduction to the research as stated in chapter 1, chapters 2, 3 and 4 discuss the current situation (‘as is’) in the construction industry, which accordingly gives an answer to the first research question ‘How is the construction industry currently organised and what trends can be identified’.

Chapter 2 elaborates on the characteristics of the construction industry in terms of economic figures such as turnover and profit margins, the industry structure, peculiarities of construction compared to other industries, characteristics of large infrastructure projects and key actors involved. Chapter 3 explains in detail what forms of collaboration and procurement are present in the industry, the spectrum of integrated contracts and liabilities. The explanation of the current situation concludes with chapter 4, where the most important trends in construction are described.

Next, chapter 5 and chapter 6 discuss the future situation (‘to be’) in a supply-driven construction industry, which accordingly gives an answer to the second and third research questions ‘How will the future supply-driven construction industry be organised?’ and ‘What consequences in terms of changing positions and roles can be identified for the consultancy and engineering sector?’.

First, chapter 5 elaborates on several theories that are used towards the conceptualization of the supply-driven construction industry. These theories include the production-based perspective of construction theory, the economics-based perspective of construction theory, the concept of customer-order-decoupling-point, basic organization theory, theory of the value chain and competitive advantage and last of all this chapter ends with a theoretical visionary view on the future construction industry called ‘the Living Building Concept’. Chapter 6 gives a view on the supply-driven construction industry, the implications for consulting engineers and the future positioning options for consulting engineers.

As the current situation (demand-driven) and future situation (supply-driven) are described, the research continues with the investigation of the future positioning and the corresponding required capabilities and strategies (‘how to’). This will give an answer to the fourth and fifth research questions ‘What position and role in a supply-driven construction industry fits DHV best’ and ‘How can the new industry position for DHV be achieved?’

Chapter 7 investigates the opinions of DHV managers through the questionnaire survey. First, this chapter explains the research approach of the survey, the design of the questionnaire and the sample. The remaining part of the chapter highlights the results of the questionnaire. These results are the required future capabilities, the strengths, weaknesses, opportunities and threats (SWOT) and the expectations and preferences of DHV-management.

The results of the questionnaire together with the other (theoretical) research findings and the final management interview are the input for a discussion towards strategies in chapter 8. Every positioning option, as defined in chapter 6, is discussed to see if this position is fit, promising and preferred at DHV. Finally, chapter 9 provides the conclusions and recommendations.
2. Characteristics of the construction industry

In the construction industry, some specific characteristics can be identified compared to other industries. This chapter will elaborate on the most remarkable characteristics of the construction industry in terms of economic figures, industry structure, peculiarities of construction, large infrastructure projects and actors involved.

2.1 Economic situation

Looking at the profit margins in figure 2.1-a, one can observe that the profit margins are relatively low for both housing, commercial and civil construction sectors. The profit margins mainly fluctuate between 2% and 4% and therefore the construction industry may be considered a low profitable sector. Furthermore, one aspect where differences occur between on the one hand housing and commercial construction, and on the other civil construction, is the percentage turnover from either public or private clients. Figure 2.1-b shows that the percentage turnover from public clients is approximately 50% in civil construction and only 10% in housing and commercial construction.

To conclude, another difference occurs when looking at the way projects are acquired (figure 2.1-c). In civil construction, approximately 60% of the projects are awarded through tendering where in housing and commercial construction this is only 25%.

Figure 2.1-a: Profit margins (%) in the Dutch construction industry (Bouwend Nederland, 2005).

Figure 2.1-b: Turnover (%) from public clients (Bouwend Nederland, 2005).

Figure 2.1-c: Turnover (%) through tendering (Bouwend Nederland, 2005).
2.2 Construction industry structure

Industrial organisational economics provide the underlying theory of how industry structure drives competitive behaviour and determines industry profitability, Grant (2002). One extreme point on the spectrum of industry structures is the situation of monopoly, the other extreme is the situation of perfect competition. By examining the principal structural features and their interactions for the construction industry, it is possible to predict the type of competitive behaviour likely to emerge and the resulting level of profitability.

Table 2.2-a shows that 60% of the construction enterprises only have one employee. Small enterprises (1-10 employees) constitute 32%, medium enterprises (10-100 employees) 8% and the large construction enterprises (>100 employees) only represent less than 1% of the number of enterprises (figure 2.2-a). This indicates that in terms of the size of the construction firms, this industry is very fragmented.

Another remarkable finding is that the total number of enterprises in the Dutch construction sector has doubled from 41,100 in 1993 up to 81,690 in 2006 (CBS, 2007). Closer analysis of the rapid growth of the number of construction enterprises shows that almost all of this growth is caused by enterprises that do not have employees on payroll, i.e. self-employed (figure 2.2-b).

The construction industry consists of many firms and the level of rivalry is high (expect certain specialty niches). The ‘largest few’ construction firms do not dominate ‘the many smaller’ construction firms. The structure of the industry is the opposite of concentrated, namely fragmented. The entry barriers are relatively low because there are no economies of scale since construction projects are unique, and prototype-like. The entry barriers are also relatively low because there is limited product development or R&D at construction companies since the product is fully specified by the (public) client.

There is no product life cycle like in other industries because products (or projects) are fully customized and one-off. In addition, product differentiation is very limited since projects are fully specified by clients and clients traditionally award contracts only based on lowest price. Differentiation, product development and R&D would be pointless as these activities involve risks and costs. Since clients put out fully specified briefs for tender, the information availability is perfect. Applying all these features to the spectrum of industry structures, one can observe that the construction industry is close to a situation of perfect competition (red oval in table 2.2-b).
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The four structural variables (rows in table 2.2-b) influencing competition and profitability are actually not the only influences. In fact, there are many factors determining the level of competition and profitability in industries. A widely used framework for classifying and analysing these factors is Porter’s five forces of competition framework. This framework consists of ‘horizontal competition’ (competition from substitutes, entrants and established rivals) and ‘vertical competition’ (bargaining power of buyers and suppliers).

As the industry structure determines the competitive behaviour and the profitability of the industry, the structure of the construction industry matches the profitability stated in paragraph 2.1. The construction industry appears to be in a situation close to perfect competition with intense competition and correspondingly low profit margins.

Table 2.2-b: The spectrum of industry structures (Grant, 2002).

Figure 2.2-b: Rapid growth of self-employment in the Dutch construction industry (CBS & Bouwend Nederland, 2005).
2.3 **Peculiarities of the construction industry**

There are many peculiarities found by several authors in literature that indicate why construction is different from other (production) industries. The most important peculiarities can be clustered into five main categories: one-of-a-kind nature of projects, site production, temporary organizations, demand-driven construction and fragmentation of the construction process.

1) **One-of-a-kind projects:**
First, the one-of-a-kind nature of construction output is caused by differing needs and priorities of the client, by differing sites and surroundings and by differing views of designers on the best design solutions. The materials, components and skills needed are usually the same or similar. Koskela (2003) argues that from the point of view of contractors and design offices, there is often continuity and repetition; roughly similar projects and tasks recur. Nevertheless, the construction supply chain is a typical engineer-to-order supply chain, with every project creating a new product or prototype.

As the client initiates the entire supply chain from concept (design) to production (realization), one can characterize this industry as almost pure customization. In other industries customers (clients) are surprised by the suppliers (market). In construction, clients specify their own product so not the client is surprised by suppliers, but instead the suppliers are surprised by the demand of the client. In construction (especially large infrastructure) no product development takes place, except for small specialist innovations or innovations in building methods. Every project is custom-made according to clients’ wishes and requirements and therefore prototype-like. One common known feature of a prototype is that a prototype contains errors or suboptimal functioning. In construction there is no assortment, catalogue or ‘shop window’ where clients can choose their product and suppliers do not develop product families. As construction projects are unique (one-off) and not repetitive there is also very little marketing and branding involved in construction.

2) **On-site production:**
Second, construction is characterized by site production, a feature shared by only a few other industries like mining and agriculture. Following features of site production are found in construction:

- Site as a (input) resource.
- Lack of shelter.
- Local resources (materials, labour) and conditions (geology, environment).
- On site production infrastructure (machines, manpower etc.).
- Space needed by production (mobile workstations).

These features of site production add to the uncertainty and complexity of construction in comparison with stationary production (manufacturing plants). Due to the fact of on-site production, the construction supply chain is a converging supply chain directing all materials to the construction site where the object is assembled from incoming materials. The ‘construction factory’ is set up around the single product, in contrast to manufacturing systems where multiple products pass through the factory, and are distributed to many customers (Vrijhoef & Koskela, 2000).

3) **Temporary (ad-hoc) organizations:**
Third, the construction project organisation is usually a temporary organization specifically formed for the purpose of the particular project. The temporary structure is reinforced by the fact that often the project is (partly) dependent on local labour, expertise, materials etc. Moreover, the fact that many contractors do more or less the same, contractors and sub-contractors are exchangeable. The nature of relationships is very temporary (short term) and the intensity of cooperation is not high (fragmented tasks, responsibilities, specialties). Learning and innovation (product development) is hampered by the fact that sometimes hundreds of contractors, suppliers, and specialists work on the same site, but no one is responsible for the whole. Problem-solving takes place on project level and on-site, but is not really learned or managed on firm level because of the scattered involvement of different firms. Innovations are mostly only implemented on project level but not on firm level. As for every project a completely new network of supplying parties is formed and projects are geared towards cost reduction and efficiency, there is no incentive for continues improvement.
4) Demand-driven construction process:
In civil engineering, projects are initiated by clients and procurement is the comparison of promises; the proposals to choose from are fully specified promises. Instead purchasing (virtually) off-the-shelf products, a construction order is awarded based on the client’s specifications while it is unknown whether the process and built object are eventually perceived satisfactory.

Three scale levels are often distinguished (De Ridder, 2006). The highest level is the macro or systems level like a port-system, estuary-system, cities-system etc. The second is the meso or component level like civil engineering objects for instance bridges, tunnels, stadiums etc. The lowest system level is the micro or element level like sub-components and parts that can be combined. Through the project phases, the scale level starts on the broad systems level and ends at the element level after detail design is finished. A detailed description of the different project phases is provided in the glossary in appendix G.

Traditionally after the detail design stage, the tender package (construction specifications) is competitively tendered in the market. Contractors submit a proposal and the lowest bid gets the contract awarded. In the realization stage, contractors make works preparation and execute the work. After handover of the works in the traditional construction process, the maintenance is the responsibility of the client again. After the operation stage (lifetime) of the construction, the works need to be upgraded or demolished and perhaps recycled.

In figure 2.3-a below, an overview is given of the construction process over the lifecycle from initiation until demolition. It shows that traditionally construction contracts are awarded after detail design (Bid-Build). Other contract types and forms of procurement are discussed in chapter 3. It must be noted that the construction process is not as linear as the figure suggests. For example, the sequential design stages are actually iterative elementary design cycles on different decomposition levels. In addition, design and realization stages can sometimes overlap (concurrent engineering).

This fragmented and demand-driven construction process can lead, especially in the case of complex projects, to unacceptably high costs of additional work\(^5\) that can lead to serious conflicts between client and contractor. Winch (2000) argues that the principal problem of this traditional procurement model is the double dynamic of adversarial relations and over-engineering (figure 2.3-b).

\(^5\) In Dutch: Meerwerk.
Central to this traditional demand-driven model, which Winch calls the professional system, is the selection of the contractor based on lowest price after a competitive tender based on a complete design. The desire by the client to get the ‘best deal’ creates a dynamic of adversarial relations in which transactions costs escalate as production costs appear to be pushed down.

One measure of adversarial relations and cause of rising transaction costs are the number of trials in court, but this is only the tip of the transaction costs iceberg. “Much more insidious is the effort spent
by all parties on avoiding disputes through writing increasingly complex contracts, auditing the performance of suppliers by hiring third parties to ‘manage’ them, and the opportunity cost of the effort not spent in actually trying to reduce production costs” (Winch, 2000). Paradoxically, the intended cost reduction of competitive tendering - as costs are largely determined by design decisions in competitive tendering on complete designs, and contract prices are fixed - there is little opportunity to reduce costs; this appears to be a cost control, rather than a cost reduction process. Figure 2.3-c depicts this contradiction of decreasing influence and increasing information.

The second and linked dynamic is over-engineering and consequently unnecessary costly designs. As complete responsibility for the design is passed to the client’s consulting engineer, consulting engineers try to protect themselves against litigation for defects in their designs. In order to minimise opportunistic behaviour by contractors, consulting engineers specify the product completely. Although consulting engineers must sometimes enact standards or guidelines set by the client, the risk of litigation also encourages consulting engineers to allow high safety margins in their designs leading to over-engineered and therefore costly designs. Winch (2000) also argues that designers’ (inevitable) lack of experience with site processes means that their specification decisions do not reflect site conditions or the capabilities of contractors. This creates rigidity in the design, which tends not to be fully optimized in relation to the problems of construction.

5) Fragmented construction industry:
In construction, clients cannot choose their desired product from a ‘shop window’ or catalogue like in other industries. Since most construction projects are prototype-like and one-of-a-kind projects, clients buy a product that does not yet exist. Demand and supply are not synchronized; demand and supply are sequential in time unlike buying a desired product from a shop window. Clients specify their demand in terms of requirements and ask consulting engineers to make complete designs. Consequently, the artifact is fixed in terms of quality, planning (time) and budget (costs). Next, the brief with design specification is put out to tender. The private party who promises to execute the work with the lowest price gets the contract awarded. This private party, the main or general contractor, will employ its own subcontractors as well as other subcontractors named or nominated by the client.

Large infrastructure works are complex, multi-disciplinary projects. Therefore, many subcontractors are involved in these projects. Subcontracting is like outsourcing; the two parties are not on the same scale level in the supply chain. Every subcontractor is responsible for a subset of the specifications and the outsourcing contractor tries to pass the risks of this part of the work as much as possible to the subcontractor. Eventually, parts of the work are subcontracted until the level of raw materials and standardized component suppliers. Since the only incentive for main contractors is reducing costs, all subcontractors in the supply chain are squeezed out in order to lower the costs and make profit. The Dutch construction industry can therefore be characterized as being fragmented or disintegrated. Fragmentation in the construction industry is not limited to the Netherlands, the same holds for the European construction sector.

The construction industry is not only fragmented in terms of the numbers of different sizes of construction firms, but also in terms of market segments, actors involved and professionalisms (specialty niches). Main segments that can be distinguished with limited overlap are housing (residential), commercial (non-residential) and civil construction. Many parties are involved in construction projects like clients, developers, architects, engineers, consultants, lawyers, bankers, contractors, subcontractors and suppliers. All these actors have different interests, competences and disciplines.

Construction is a fragmented industry where competitive rivalry is intense and the risk of ‘bad competitors’ driving out ‘good competitors’ is high (Porter, 1980; 1985). Because of low entry barriers in fragmented industries, profits are easily competed away by low-cost suppliers undermining quality standards. One way to increase entry barriers is supply chain collaboration and partnerships. New entrants trying to enter the market are not competitive enough when they lack a network of partners, shared knowledge and synergies.
2.4 Characteristics of large infrastructure projects

First, an impression of the positioning of large infrastructure projects is presented in table 2.4-a. Large infrastructure projects generally involve different interests and the technology is partly unambiguous but mostly ambiguous with regard to either unproven technologies, proven technologies in unproven applications or ambiguity about the size of application.

<table>
<thead>
<tr>
<th>Similar interests</th>
<th>Different interests</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technology unambiguous</td>
<td>Technology ambiguous</td>
</tr>
</tbody>
</table>

Table 2.4-a: Positioning of large infrastructure projects.

Veeneman (2006), Dorée (2001) and De Bruijn (1996) have identified several characteristics of large-scale technological projects and large civil engineering projects. Paragraph 2.3 showed that construction projects are generally one-off (project-based). This uniqueness expresses itself in technology, application and size. Since these projects involve heavy investments, often create a boost for employment and attract a lot of attention, the public interest is of great importance. Benchmarking with reference projects is often hampered by its uniqueness and the unproven (unique) technology used, the unique application of a proven technology or the size (scale) of application will also hamper full understanding of the technology, bottlenecks and success.

The realization requires professionalism. A lot of ‘in depth’ specialist knowledge is involved in these type of projects like technology, finance, judicial etc. Since specialists have a strong tendency to maximize their sub-discipline, professionalism hampers internal cooperation and also their specialist knowledge hampers external control.

Furthermore, large infrastructure projects involve many dynamics during the project life cycle. Changing preferences, technological insights and scope hamper predictability and control. Sub-projects can deliver new technical possibilities that are crucial to the course of the project as a whole. Tension can arise between the ‘managerial’ attitude focused on controlling the dynamics and the professional engineers’ drive to include innovations.

Development and deployment run parallel. It is often unknown whether the chosen techniques will achieve the objectives (for instance the rail safety system of the Dutch HSL). During implementation, innovations or new applications of existing techniques are still necessary to achieve the design requirements. There are several and often competing ways of realizing the objective. In addition, context dynamics like political interference, acceptance and rejections of permits or other rules and regulations (European procurement law) can have a substantial influence on the project.

The size of large infrastructure projects results in a heavy burden on resources. Frequently referred to as ‘big jobs’ or ‘mega projects’, these projects involve heavy resources (financially, personnel, equipment etc.). Therefore, large infrastructure projects also involve inflexibility and the risk of entrapment (lock-in). Large technical projects are indivisible; half a bridge is not a bridge (irreversibly sunk). On the other hand non-technical projects are divisible, for instance a reform program is still a reform when stopped halfway. Indivisibility may not exist at every level of aggregation due to sub-systems. A motorway of 100 km, which is finished for 80 km and connected to the existing network, is
still a motorway. Consequently, the question is should this project be considered a partial success or total failure? However, indivisibility does not preclude splitting up large projects into smaller parts.

Veeneman (2004) identifies four types of complexity on interfaces, based on technological and social complexity. Technological internal interface is for instance the interface between foundation and superstructure of a high-speed rail link. Technical external might be the interface between a bridge and a waterway. Social internal might be the interface between electricians and safety system engineers, while social external might be the interface between project leader and government decision-making bodies (table 2.4-b).

<table>
<thead>
<tr>
<th></th>
<th>Internal</th>
<th>External</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technological</td>
<td>Sub-system to sub-system</td>
<td>System to environment</td>
</tr>
<tr>
<td>Social (managerial)</td>
<td>Project member to project member</td>
<td>Project team to environment</td>
</tr>
</tbody>
</table>

Table 2.4-b: Complexity on interfaces: four types.

To conclude, design and realization phases were traditionally disintegrated. Therefore, optimization, fine-tuning and synchronization between design (product) and construction (production process) are very problematic. In chapter 3 and 4, alternative types of procurement procedures and trends in contracts are described.
2.5 Key actors in the industry

Paragraphs 2.3 and 2.4 mentioned that construction mostly involves project-based processes. Figure 2.5-a illustrates the types of actors, activities and knowledge flows found in project-based construction activities (Gann & Salter, 2000).

A hierarchical representation of value consumers and value producers is depicted in figure 2.5-b. Value consumers can be ordered from a single client with a specific interest in a construction object, up to the society with a general interest. Value producers can be ordered from a single contractor responsible for delivery of the construction object with a certain value, up to a group of suppliers delivering the smallest sub-parts.

In the traditional form of procurement (bid-build), the main tasks are clearly divided between the client, the consulting engineer and the contractor. The client is responsible for taking initiative, coordination and financing. The client involves a consulting engineer to work out the list of requirements into a design with specifications. After a competitive tender, the contractor takes care of the realization of the project. Now that new forms of procurement have emerged in the last two decades, tasks are transferred between the parties involved. Consulting engineers increasingly work also for contractors (supply-side) because contractors are more and more involved in design and coordination activities. This means consulting engineers can work both at the demand-side and at the supply-side, but not at the same time or on the same project because of a ‘conflict of interests’. Different forms of procurement are discussed in detail in chapter 3.
Clients:
Few construction clients have altered their procurement strategy, mostly demanding higher performance and dedication from their supply base, often resulting in long-term and intensified collaborative arrangements with firms in the supply chain (e.g. frameworks) (Vrijhoef et al. 2005). In the Netherlands, the government agency for transport, public works and water management named Rijkswaterstaat (public client) has redefined their core business and is in a transition phase (Rijkswaterstaat, 2004).

<table>
<thead>
<tr>
<th>Past</th>
<th>Future</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technical exploitation with inward focus</td>
<td>Network manager with customer focus</td>
</tr>
<tr>
<td>‘King’ in the region</td>
<td>Partner (level player)</td>
</tr>
<tr>
<td>Reinventing the same</td>
<td>Coherence and collaboration</td>
</tr>
<tr>
<td>Executive leader</td>
<td>Professional client (contract engineering)</td>
</tr>
<tr>
<td>Aim for total in-house knowledge</td>
<td>In-house outlined knowledge</td>
</tr>
<tr>
<td>Hampering organisational management</td>
<td>Enabling organisational management</td>
</tr>
<tr>
<td>Avoid (organisational) problem-solving</td>
<td>Resolving (organisational) problems</td>
</tr>
</tbody>
</table>

Table 2.5-a: Impression of the transition of Rijkswaterstaat towards a new organization (Rijkswaterstaat, 2004).

Rijkswaterstaat was formerly seen as a corps of engineers but nowadays it aims to act as a network-manager and infra-provider with a strong customer focus. An impression of the transition towards a new organisation and professional client is presented in table 2.5-a and 2.5-b.

<table>
<thead>
<tr>
<th>Past</th>
<th>Future</th>
</tr>
</thead>
<tbody>
<tr>
<td>In-house design and innovation</td>
<td>Stimulate innovation in the market</td>
</tr>
<tr>
<td>Detailed designs and briefs (demand)</td>
<td>Outlined designs and demand</td>
</tr>
<tr>
<td>Lowest price</td>
<td>Price/quality + performance</td>
</tr>
<tr>
<td>Decentralized procurement</td>
<td>Centralized procurement</td>
</tr>
<tr>
<td>Various contracts</td>
<td>Uniform standard contracts</td>
</tr>
<tr>
<td>Technical requirements</td>
<td>Functional requirements</td>
</tr>
<tr>
<td>‘Superior’</td>
<td>(Business) Partner</td>
</tr>
</tbody>
</table>

Table 2.5-b: An impression of the transition of Rijkswaterstaat towards a professional client (Rijkswaterstaat, 2004).
Rijkswaterstaat aims to (1) make optimal use of markets, (2) an optimal price/quality ratio and (3) be an efficient organisation. The repositioning of Rijkswaterstaat as network-manager is visualized in figure 2.5-c.

**Contractors:**
As indicated in paragraph 2.3, the market of contractors is very fragmented. In the Netherlands a few large main contractors exist like BAM, Heijmans, VolkerWessels, Ballast Nedam or Dura Vermeer, but also many smaller (sub)contractors and specialist suppliers exist. Traditionally, contractors were typical construction firms focusing on realization only. Nowadays contractors have increasingly extended their business into design and engineering phase (forward integration) and maintenance or facility management (backward integration).

Many contractors/suppliers have redefined their businesses based on the clients’ altered procurement methods, but apart from that, also altered their businesses based on own strategic change to move away from project delivery towards integrated product development (Vrijhoef et al., 2005). As an example, a new business strategy of a Dutch top-5 contractor is stated on its website as follows:

“Ballast Nedam Infra is moving further away from its role as a traditional contractor. Apart from accepting and undertaking projects, we are concentrating increasingly on concept-based thinking and the provision of overall solutions for (complex) infrastructural challenges. Our main concern here is to solve problems or to meet a need in the form of products and services. This therefore means that we no longer regard the completion of projects or subprojects as a goal in its own right”.

**Consulting engineers:**
As mentioned in paragraph 2.3, the construction process roughly consists of the functions initiative, orientation, feasibility study, project definition, design, tender, construction (realization), exploitation and maintenance. For consultancy and engineering firms, the level of process integration is determined by whether they exclusively focus on the design and engineering phase, solely delivering design and engineering capacity, or include also other functions in earlier of following phases.

Consultancy and engineering firms who also employ earlier and other functions like feasibility study, program/project management and tender/procurement strategies can be considered forward integrated consulting engineers. Consultancy and engineering firms who also employ later and other functions like contract management, construction management and asset/facility management can be considered backward integrated consulting engineers. Consulting engineers who are both forward and backward integrated can be considered fully integrated.
Besides extending business functions either forward or backward in the construction process, consulting engineers can also choose to innovate and take initiatives themselves as project developers or concept developers. The level of innovative entrepreneurship of consultancy and engineering firms is determined by the involvement in activities and functions like trend watching, entrepreneurial corporate development, research and development, customer/end-user orientation and risk-taking participation. Combining the level of process integration and the level of innovative entrepreneurship, one can position consulting engineers on a continuous scale with two extremes (EIB, 2006).

On the first extreme one can find consulting engineers who exclusively focus on design and engineering activities and thereby solely providing standard capacity on a fees-basis (‘traditional’). On the other extreme one can find consulting engineers providing innovative integrated solutions and services covering several process functions from initiative up to hand-over and facility/asset management (‘modern’). ‘Innovative’ consultancy and engineering firms exclusively focus on their traditional design or engineering activities, where they offer innovative solutions. ‘Integrated’ consultancy and engineering firms are not very innovative but have integrated either forward, backward or both.

Diverging from the ‘traditional’ position, consultancy and engineering firms can create a competitive advantage. The combination of the level of process integration and the level of innovative entrepreneurship is depicted in figure 2.5-d and can be helpful in characterising consultancy and engineering firms.

![Figure 2.5-d: Characterisation of consultancy & engineering firms and specifically DHV (EIB, 2006).](image)

Applying the characterization scheme as depicted in figure 2.5-d to the current position of DHV, one can observe that DHV is an integrated consultancy and engineering firm (blue area in figure 2.5-d). DHV can provide financial, judicial and economical management consultancy during feasibility and planning stages. Furthermore, DHV offers advises regarding tender procedures, procurement strategies, contract strategies, program management, functional designs, environmental impact assessments, project management, and of course traditional design and engineering tasks. DHV also provides management functions during realization like contract management or facility/asset management. The level of innovative entrepreneurship appears to be limited at DHV.

The level of innovative entrepreneurship of DHV is higher in its foreign activities than in the Netherlands. Furthermore, DHV aims to act more at the higher end of the advisory column (central government level, projects with national interests). This aim for the higher and strategic end of the advisory column might result in a shifting position towards less ‘technical’ consultancy like
organization, management and financial consultancy. To conclude, DHV can be considered both forward and backward integrated.

Additional to the previous two distinguishing factors being the level of process integration and the level of innovative entrepreneurship, one can also distinguish between consultancy and engineering firms involved on operational, tactical or strategic level during different phases of the project life cycle (figure 2.5-e). The curve that is added in figure 2.5-e indicates the level of involvement of DHV during different project phases.

<table>
<thead>
<tr>
<th>Initiation</th>
<th>Planning</th>
<th>Realization</th>
<th>Operation</th>
<th>Demolition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strategic</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tactical</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operational</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 2.5-e: Different levels of involvement of consultancy and engineering firms.

Moreover, one might also distinguish between the type of client/customer and the type of market. For instance, large infrastructure projects are typically commissioned by public clients, where industrial facilities are typically commissioned by private clients. Furthermore consulting engineers can either be involved in activities at the public-side like acting as (delegated) public client’s representative, or at the supply-side (private market) like participating in a design & construct proposal.

Another classification of consultancy and engineering companies is depicted in figure 2.5-f. Consulting engineers might be involved in public and private markets, on different scale levels like international, national, provincial (regional) or municipal (local), and on strategic, tactical and operational levels. DHV increasingly aims to participate in large-scale transportation infrastructure projects. This implies a shift towards more focus on projects on a national or provincial scale level and also organization and management consultancy.

Figure 2.5-f: Different markets for consulting engineers.
2.6 Summary

This chapter shows the most important characteristics of the construction industry. The construction industry appears to be an industry close to the situation of perfect competition with intense rivalry and correspondingly low profit margins. As the construction industry is different from most other industries, the five most important peculiarities found in construction are:

- One-of-a-kind nature of construction projects (resembling prototypes)
- On-site production
- Temporary and ad-hoc organizations
- Demand-driven construction process (close to full customization)
- Fragmented in terms of the number of enterprises, involvement of different parties with different disciplines in different project phases

Furthermore, the civil engineering sub-sector of transportation infrastructure has distinct additional characteristics compared to commercial (housing and buildings) or industrial sub-sectors. Transportation infrastructure projects generally involve a high level of complexity in terms of technological and social interfaces. For instance, the uncertainty and dynamics in formal planning procedures, unproven technologies or applications, a large public interest, the size of the project and resource intensiveness (irreversibly sunk) shows this complexity.

Looking at the actors involved, the demand side in construction consists of value consumers who can be ordered from a single client with a specific interest in a construction object, up to the society with a general interest. The supply side consists of value producers who can be ordered from a single contractor responsible for delivery of the construction object with a certain value, up to a group of suppliers delivering the smallest sub-parts. Within this ordering, key actors in the industry are the clients, contractors and consulting engineers. The relationships and roles of the key actors are changing. Consulting engineers were traditionally the ‘right hand’ of the client, but as clients are returning to the core business, consulting engineers increasingly work at the contractors’ side. More trends in construction are explained in chapter 4.
3. Forms of procurement procedures

This chapter elaborates on different forms of procurement procedures in civil engineering. It is important to provide an overview of different forms of procurement procedures in construction because it determines the relationship between demand and supply. The term procurement procedure is frequently used and confused with different types of integrated contracts. For instance, public-private partnership (PPP) is a form of collaboration, not a type of contract. Therefore paragraph 3.1 and 3.2 first describe what is referred to when using integrated contracts and different forms of project organization and liabilities. Moreover, the most important forms of procurement are described in the following paragraphs.

3.1 Spectrum of integrated contracts

This paragraph discusses the spectrum of integrated contracts in the construction industry. For many years a traditional form of procurement procedure, the bid-build model, dominated the relation between client and contractor. The client provides the design details and the contractor builds the works in accordance with the client’s design. The responsibility for the design lies with the client and the responsibility for construction lies with the contractor.

Due to the fact, that the design is being provided by (or on behalf of) the client and the client’s supervision of the contractor, implies that the client is actively involved in the realization of the construction. The involvement of the (public) client takes quite a lot of staff capacity, which is nowadays commonly undesired. As mentioned earlier, ‘back to core business’ is the ambition of many (public) clients like Rijkswaterstaat in the Netherlands. This process of retraction has important consequences for the traditional model of procurement in terms of meeting the ‘new’ requirements of less involvement of the client.

Increasingly, design activities are transferred from client to contractor and new integrated contacts are developed on a sliding scale. Starting point of this sliding scale is the traditional model as can be seen on the left side in figure 3.1-a. The most integrated contract is DBFMO, where even exploitation and financing are part of the contract.

![Figure 3.1-a: Spectrum of integrated contracts, adapted from De Ridder (2006b).](image-url)
Contract strategies for consulting engineers:
Consulting engineers have four different contract strategies that can be distinguished (ONRI, 2005). In figure 3.1-b two axes are depicted, namely the type of reimbursement and the level of design liabilities (guarantees). The type of reimbursement system can be a ‘cost plus’ system, where the client reimburses all acceptable and reasonable costs of which the consulting engineer can demonstrate that he has incurred those expenses. Moreover, there can be a ‘fixed price’ system, where the consulting engineer receives a fixed amount of money (lump sum, sometimes combined with some kind of performance bonus/penalty) concerning the services rendered or product delivered.

The ‘cost plus’ system can be considered an effort-based obligation (input-based) while the ‘fixed price’ system can be considered a result-based obligation (output-based). The effort-based obligation is typical for work between clients and consulting engineers (quadrant 1 and 2). Although effort-based obligations generally involve lower risks, consulting engineers are increasingly participating in result-based obligations. Most risks can be observed in the fourth quadrant where the consulting engineer has both design liability and a result-based obligation. Higher risks are generally only accepted if the potential profit/return is also higher.

Figure 3.1-b: Contract strategies for consulting engineers, adapted from ONRI (2005).
3.2 Spectrum of liabilities

The most common types of contracts that are known in either the Netherlands or international can be clustered into five categories according to the level of liabilities (ONRI, 2005). The three most important criteria identified in order to distinguish these clusters are:

- Who finances?
- The level of acceptance of responsibilities and liabilities of design/realization
- Result-based obligation (fixed price / lump sum) or effort-based obligation (cost plus / fees)

The following five clusters are identified:

1. Integrated contracts including finance:
   Two party organization between the client and the full-service provider including finance, design, realization, maintenance and exploitation (BOT, DBFM etc).

2. Integrated contracts for contractors:
   A two party organization between client and main contractor where design and realization are integrated (DB, EPC/turnkey etc).

3. Traditional contracts:
   Traditional roles and responsibilities; the design and realization stages are divided (design – bid – build).

4. Integrated engineering contracts:
   Involvement of consulting engineers in more phases of the construction process. This is also known as backward integration of consulting engineers involvement (management contracting, construction management etc.).

5. Management contracts:
   Specialist consultants, consulting engineers or managers are involved in different tasks of the construction process. Disintegrated types of contracts like design management, project management etc.

Consequently, a ladder of liabilities is presented in figure 3.2. The first cluster on top of the ladder includes finance and is therefore the most comprehensive cluster with the highest risks/liabilities. The success of the project for the contractor/consortium depends on the outcome of the project (output-based). The fifth cluster at the bottom of the ladder includes only effort-based obligations like project, design or construction management (consultancy). Consequently, the risks/liabilities are very limited in this cluster.
Traditionally (cluster 3), supply chains were geared towards the realization (production) only. As represented by clusters 1 and 2, supply chains have been extended by forging stronger links to design (in DB), to financing and operation (in BOT/DBFO) and to maintenance (in DBM). This highlights the approaches towards more integrated and synergistic supply chains in the construction industry (Palaneeswaran, 2001).

Liabilities for the contractor in traditional design-bid-build contracts (cluster 3) only involve the physical construction, construction quality control/assurance and extreme weather conditions. From the third cluster (design-bid-build) towards the first cluster (integrated + finance), risks/responsibilities are increasingly transferred to the contractor like design, design defects, constructability, maintenance, operations or quality of services.

Some risks/responsibilities can be shared between the client and the contractor, but can also be transferred to the contractor. These risks/responsibilities can be approvals/permits, co-ordination of works with other agencies, ground/soil conditions or changes in legal and political/administrative systems (Palaneeswaran, 2001).

Figure 3.2: Ladder of liabilities, adapted from ONRI (2005).
3.3 Traditional Bid-Build procurement

The principal characteristic of a ‘Bid-Build’ contract is the uniform and unambiguous way in which this model is drawn up and the clearly separated functions of the parties. The client is responsible for the initiative, project definition, design and for the provision of the tender package. Often the client hires a consulting engineer to take care of (a part) of the design. The specifications are written with the aid of a standard system (RAW\textsuperscript{6}), based on descriptions of the works detailing ‘output performances’. The client (or his consulting engineer) supervises the works during construction.

The contractor ‘designs’ the method of construction (works preparation), makes a planning schedule for the works and executes the works in accordance with the contractual obligations, i.e. the technical and administrative conditions. In the Netherlands, these administrative conditions can be derived from the so-called UAV\textsuperscript{7} or UAV-GC\textsuperscript{8} model. In the international context, these conditions can be derived from one of the FIDIC\textsuperscript{9} standard contracts. The ‘Bid-Build’ procurement procedure is based on the traditional model of the building process. In this model, the well-defined and legally separated tasks ensure that a sound process is followed, in which the participants first finalise all tasks in each stage before moving on to the next one. Unfortunately, this causes a rather static process. (De Ridder, 2006b) This process is depicted in figure 3.3-a.

The application of a ‘Bid-Build’ procurement procedure has a number of advantages. The detailed and standard clauses give hardly any reasons for discussion. The parties clearly know their position, tasks, authorities and responsibilities and it offers good checking possibilities after each stage. For procurement of standard works, the ‘Bid-Build’ model is very appropriate to use. The client knows exactly what he wants and many contractors are able to deliver the construction object.

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\textsuperscript{6} Rationalisering en automatisering in de grond-, weg- en waterbouw (GWW).

\textsuperscript{7} Uniforme Administratieve Voorwaarden

\textsuperscript{8} Uniforme Administratieve Voorwaarden Geïntegreerde Contracten

\textsuperscript{9} Fédération Internationale Des Ingénieurs-Conseils or International federation of consulting engineers
A supply-driven construction industry for transportation infrastructure

However, in addition a number of disadvantages can be found. Because of the sequential character of the activities, the strict separation of design and construction stages causes a ‘slowdown’ effect on the construction process.

Another consequence of the sequential character of activities is that clients (demand side) cannot explain their wishes without knowing the possibilities and opportunities. Demanders specify desirable products that are not possible and suppliers are developing possible products that are not desirable. In the ‘consumers world’ demanders and suppliers meet each other in a market situation as highlighted in figure 3.3-b (products which are not only desirable but also possible).

Furthermore, bid-build procurement involves disproportional transaction costs (figure 3.3-c). This is caused by the fact that at first, client’s specifications must be correct (consultant’s paradise) and then the supplier’s offer must be correct. A fixed price should be precisely estimated (consultants paradise) and last, contractual costs are made by both parties in order to make a proper agreement on deliveries against a fixed price (lawyer’s paradise).

Another disadvantage is that suppliers scan for omissions in specifications, lower the price, get the job and create profit with additional work. Unaware and incompetent suppliers not able to analyse risks, associate their offer with a very low price and will get the job (survival of the un-fittest). Lowest and fixed price contracts induce lowest price subcontracts. The main consequence is that the complete supply chain is not focused on creating value, but instead focused on reducing costs (quality problems). There is also hardly any possibility to deal with changing perceptions since specifications and price are fixed from the start.

De Ridder (2006b) also mentions that in the traditional procurement procedure, expertise of the contractor can only be used in the construction / execution stage and leads to sub-optimisation (construction time and construction costs) of the realisation process. Therefore, there is a high chance of additional works arising because of the inadequate ‘tuning’ of design and construction.

To conclude, according to the economic law of perfect competition (free market), the price equals the costs and no profit is left for the contractor (see chapter 2.2). Consequently, some contractors or suppliers try to make price agreements in order to make profit.
3.4 Design-team procurement

A design-team structure is a pre-contractual collaboration between the client and contractors. The purpose of a design-team structure is to break down the walls between subsequent building stages such as tender preparation and construction, in order to make it possible to use everyone’s skills and experiences as soon as possible. The independence and own responsibility of each member remains guaranteed. The design-team structure improves the synergy between the preparation and construction stages: the building processes become more efficient and the time for preparation and construction can be shortened. The design team process is depicted in figure 3.4.

One advantage of a design-team is that in the design stage, advantage is taken of the expertise of the professional contractor with respect to methods of execution, construction cost and products. Likewise, the designing party transfers its knowledge to the party executing the works. Design and execution are better tuned so that the chance of additional work is less and better control of the construction process is achieved. In this way construction time will be less and the result will have more quality (De Ridder, 2006b).

Disadvantages are that the distribution of responsibilities can become very complex because the client has several contracts with different parties. Furthermore, full competition is lacking as in most cases the design-team’s contractor will build the project. In this way, there will be no ‘lowest achievable’ price.

Figure 3.4: Process of a design-team form of collaboration (De Ridder, 2006b).
### 3.5 Integrated procurement (Design-Build and turnkey)

In ‘Design-Build’ procurement\(^{10}\), the contractor both designs and provides the works. In this case one speaks of forward integration, because the contractor takes responsibility for a part of the preceding process(es) (see figure 3.5-a). Several variations (heavy/light) of design-build contracts are depicted in figure 3.5-b. The difference between design-build and turnkey is that the (steering) influence of the client is more limited in turnkey than in a design-build form of procurement. In the UK the term ‘prime contracting’ is frequently used. According to Defence Estates (UK executive agency of the Ministry of Defence) a prime contractor can be defined:

...as having overall responsibility for the management and delivery of a project, including coordinating, integrating the activities of a number of sub-contractors to meet the overall specification efficiently, economically and on time.

![Figure 3.5-a: Process of a Design-Build form of procurement (De Ridder, 2006b).](image)

Design and realisation are in one hand. In most cases, this is the hand of the construction company, but not necessarily always. For now, it is assumed that the contractor is the construction company. The question “How shall the result be reached?” is to be answered by the contractor. The client’s involvement will therefore mainly concern the definition of its requirements, and the possible quality assurance system. With this type of procurement, there is no traditional form of supervision from the side of the client, although the contractor shall allow him a general authorisation for inspection to make sure of compliance with the contract. This building process is a more dynamic affair than the traditional one. Time and quality can be gained by integrating (detail) design and construction.

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\(^{10}\) In Dutch: Design & Construct
Advantages for the client are that the client has to deal with only one party, which makes the relations simpler between the parties involved in design and construction. There will also be less discussion about responsibilities and liabilities. The design partner cannot argue that construction is poorly built, and the construction partner cannot argue that the design is poor. As specific construction knowledge is introduced in the design process, the execution of works is improved.

It is noted that in professional literature an important advantage is seen in transferring the risks to the contractor. This is incorrect because a ‘Design-Build’ procurement procedure is only a form of task distribution and does not give an answer to the question how risks are, or shall be, distributed between the parties involved. The distribution of risks depends on the choice of a certain reimbursement system (De.Ridder, 2006b).

It is important to realise that many options exist here, ranging from DB-cost-plus to DB-fixed-price contracts, and everything in between (De Ridder, 2006b). There is an important major difference between the two reimbursement systems that govern the risks that parties bear in a collaboration. In the case of a ‘cost plus’ system the final price of the works is determined in retrospect (e.g. re-measurement contract), but when a ‘fixed price’ system is used the final price is determined beforehand (e.g. lump sum contract).

Disadvantages for the client are that the number of companies capable of performing DB tasks is not that large. It implies that the number of competing companies is also not as large as in the market for traditional construction projects. This could have price consequences. Furthermore, the client is, already in an early stage, legally bound to adhere to contractual conditions (including financial regulations). This is in contradiction with the desire, in the early stages of a project, to have a certain freedom of action because a number of aspects are still vague in nature.

Advantages for the contractor are that for the construction company, accepting a Design-Build contract could be a help to profile itself for a strategic market position, because the number of companies that are competent in this field is restricted. In addition, ‘project harmony’ is improved, first, there are only two players and secondly it becomes possible to bring ‘design culture’ and ‘construction culture’ together in one organisation. Bringing these cultures together is not easy as depicted in table 3.5.
A disadvantage for the contractor is that the most fundamental difference between ‘Design-Build’ and the traditional procurement model concerns responsibilities. Traditionally the contractor is only responsible for the costs actually made, whereas in ‘Design-Build’ the contractor also becomes responsible for the (estimated) costs. Since the design stage preceding the construction stage ‘fortunately’ does not cost a great deal of money and must be finalised as soon as possible, paradoxically, in most cases the design stage is not considered very important (De Ridder, 2006b). What is not commonly realised is that the largest uncertainties actually arise during this stage. Therefore, most of the risks can be found here (figure 2.3-c).

<table>
<thead>
<tr>
<th>Cluster criterion</th>
<th>Design culture</th>
<th>Construction culture</th>
</tr>
</thead>
<tbody>
<tr>
<td>Relations and requirements</td>
<td>-</td>
<td>- Location and materials</td>
</tr>
<tr>
<td>As few as possible</td>
<td>-</td>
<td>- As many as possible</td>
</tr>
<tr>
<td>Hampers creativeness</td>
<td>-</td>
<td>- The more the better</td>
</tr>
<tr>
<td>Does not work</td>
<td>-</td>
<td>- Is stimulated</td>
</tr>
<tr>
<td>Trial and error</td>
<td>-</td>
<td>- Everything perfect in one single go</td>
</tr>
</tbody>
</table>

Table 3.5: Differences in culture (De Ridder, 2006b).
3.6 **Public-Private-Partnership (Concession-PPP and alliance-PPP)**

There are generally two important types of public-private partnerships (PPP) applicable in construction projects. The first type of PPP is the concession-PPP that is referred to in DB+ and BOT types of procurement (in the UK: Private Finance Initiative). The second type of PPP is the alliance-PPP where the public client shares risks with the private contractor/consortium. The difference between the two types of PPP is that in concession-PPP the relationship between public and private parties is unequal where in an alliance-PPP one might refer to ‘real’ partnering and co-makership or joint product development between public and private parties (v.Ham & Koppenjan, 2002).

**Concession-PPP:**

Build-Operate-Transfer (BOT) procurement is the most comprehensive form of the concession-PPP model. BOT is a procurement procedure in which a public party concedes to a private party (the concessionaire). This includes the design and provision of a completely equipped work, ready for operation, and the exploitation and maintenance of those works during a certain period: the concession period. The works are then taken over by the (public) party: the project owner. No public money is involved. Both forward and backward integration is observed here. BOT can be considered as a much extended form of Design-Build because of the integrated character of contract commitments (from feasibility up to operation and maintenance) (De Ridder, 2006b). Examples of BOT are toll roads and the channel tunnel.

**Alliance-PPP:**

At this moment, the most comprehensive form of collaboration in the construction industry is the alliance model. This form still enables the various parties to work for a common goal with their own individual interests. It originates from the petrochemical industry, specifically in the USA and UK, and they are used in those countries for more than 10 years already (De Ridder, 2006b). This form of collaboration is not really in use yet in the Dutch construction industry, except for the N201-alliance (Aalsmeer-Uithoorn). On May 30, 2006 the public client ‘Province of North-Holland’ and the contractors combination ‘Heijmans-Boskalis’ signed a real alliance contract.
3.7 Summary

Table 3.7 provides an overview of the characteristics of the different forms of procurement as discussed in this chapter. Most important conclusions of this chapter are that the traditional ‘wall’ between design and realization is broken in the new forms of procurement procedures. Contractors have integrated both forward and backward in the construction process. The traditional focus of contractors on the realization stage can be replaced by an integrated focus on both design and construction and in some forms even on the total cost of ownership (project life cycle).

Traditionally, as the construction object is fixed in terms of full specifications that are put out to tender, there is little opportunity to do things differently than the competitors. As more authority, management/control and responsibilities are left to the market, this brings much potential for the supply-side to take a production focus instead of a capacity-driven project focus. There is increasingly more opportunity for the market (contractors/consulting engineers) to do things differently compared to the rivals.

<table>
<thead>
<tr>
<th>Form of procurement</th>
<th>Characteristics</th>
</tr>
</thead>
</table>
| Traditional bid-build | - Clear division of design and realization phases  
- Clear distribution of responsibilities between parties  
- Static and fixed construction process and consequently a high chance of additional work  
- Expertise of the contractor (market) is limited to the execution stage  
- Misfit between design (desirable) and realization (possible)  
- Disproportional transaction costs (consultants and lawyers) |
| Design team | - Better tuning and synergy of design and realization phases and consequently a lower chance of additional work  
- Expertise of the contractor (market) is used during orientation and design phases  
- Distribution of responsibilities more complex due to multiple contracts (contract with the design team and with the contractor)  
- Limited competition as the design team contractor will often build the project |
| Integrated (design-build / turnkey) | - Design and construction (realization) in one hand  
- More synergy and overlap between design and realization  
- Lower transaction costs (no contracting cost with consultants, less specification costs)  
- Paradoxically the client is already in an early stage bound to contractual conditions while at this point the unknowns/uncertainties are the largest.  
- Increased use of market knowledge as contractors have control over the design and realization |
| Concession PPP (DB+ / BOT) | - Extensive integration of the building processes. In principle this model covers almost the total project’s lifecycle; from development up to and including operation (much extended form of a design-build procurement).  
- More efficient construction process due to the lifecycle focus (total cost of ownership)  
- Risks concerning design, financing, realisation, management, control and maintenance are passed to the concessionaire  
- No public money is involved |
| Alliance PPP | - Public and private parties work for a common goal.  
- Shared risks  
- Thrust and equality very important and take a lot of time at startup  
- Due to European legislation it is a less accepted and acceptable form of collaboration for public authorities |

Table 3.7: Overview of the characteristics of different forms of procurement in construction, adapted from De Ridder (2006b).
4. Trends in construction

This chapter presents an overview of trends in construction. Some trends are already discussed in chapters 1-3 while others have not yet been discussed. It is important to realize how the construction industry was traditionally organized and what trends can be observed up to now. The overview of trends might suggest that these are independent trends, but in fact, many trends in construction have partly a cause and effect kind of relationship or are intertwined. Some trends might be very general and also applicable to other industries but nevertheless very relevant for construction.

Recognition of the need to change
The first and most important trend is the recognition of the need to change the construction industry. The Latham report and Egan report in the UK, and in the Netherlands the Vos-committee on the Dutch construction industry, Duivesteijn-committee on large infrastructure projects, the construction reform council (Regieraad Bouw), the center for process innovation in building and construction (PSIBouw) and the ‘Living Building Concept’ all aim for a structural change in the construction industry.

New forms of procurement and integrated contracts
New methods of procurement and integrated contracts have emerged as a response to the recognition of the poor performance of the construction industry due to its fragmented and adversarial character. Construction processes are increasingly getting integrated like for instance Design-Team, Design-Build (DB) and Public-Private Partnerships (concession/alliance). As the construction life cycle phases are getting more integrated, the focus is also increasingly more on the total life cycle value and costs (Total Cost of Ownership).

Clients return to the core business
Public clients, but also private clients return to their core businesses. The increased competition and the aim for a more efficient organization, is expressed in clients demanding total (turnkey) solutions. Public clients in the building industry outsource facility services like security, catering, cleaning, IT and maintenance. Public clients in civil engineering, for instance infra managers for roadways, outsource maintenance of roads and traffic control. Also in-house engineering offices are being privatized or terminated. Major public clients like Rijkswaterstaat in the Netherlands aim in their business plan to become a professional client and infra-manager, making maximum use of market knowledge, creativity and innovation.

Rotation of the construction column
It is the client’s wish to be less involved in organising, designing and coordinating activities during complex works. Clients would rather just want to ‘buy’ a product or a totally integrated built service. The solution must comply as much as possible with their demand (LoR, see glossary), being some requirements (need-to-haves) and many desires (nice-to-haves). It is increasingly the client’s wish to have one focal point and clear responsibility and liability allocated at one party or consortium for the entire built service delivery.

The rotation of the construction column (see figures 4-a and 4-b) is reinforced by the transition from an efficiency-based construction industry towards an effectiveness-based construction industry. The post world-war-II efficiency-based construction industry resulted in functional specialisation, a hierarchical or outsourcing industry structure and capacity was a competitive advantage. Now, clients focus more on value/cost ratios and demand more integrated solutions. Parties lower in the construction column are integrating forward and parties higher in the construction column are integrating backward. By integrating either forward or backward in the construction process, parties also try to achieve a competitive advantage in order to gain higher profit margins.
Not in every construction segment, the rotation of the construction column is as far extended as the other. For instance in housing the level of rotation is much higher than in the buildings or civil engineering segments. Nevertheless, some evidence of this trend is observed in civil engineering, as in many countries infrastructure is being procured through BOT-contractors or DB+ contractors. Also the rise of engineering contractors, ‘all engineers’, project developers becoming contractors and contractors becoming project developers is observed.
Supply chain integration

Increasing supply chain integration and partnering. A UK review summarised in figure 4-c, is based on an investigation of the main procurement approaches that emerged in construction during the period between 1960 and 2000. This timeline is represented on the horizontal axis. The vertical axis represents the type of relationships between clients, consultants, contractors and subcontractors in terms of the degree of collaboration and integration. It is found that there is a trend towards more supply chain collaboration and strategic partnering. Partnering can be between the client (public) and the contractor (private) like in public-private partnerships as described in paragraph 3.6, or between several supplying parties like contractors, suppliers and consulting engineers (private-to-private).

The UK strategic forum for construction also adopted this approach to supply chain integration in their report ‘accelerating change’ by Egan. As a target, 20% of construction projects (by value) should be undertaken by integrated teams and supply chains by end of 2004, rising to 50% by end 2007 (Egan, 2002). This report states the following: “The major long-term benefit from integrated team working is the potential for relationship continuity. Integrated teams should be based, wherever possible, on strategic partnering. Knowledge and expertise can then be transferred more effectively from one project to the next. Whilst this is clearly of benefit to repeat clients, the benefits to one-off clients should not be ignored; such teams will be better placed to offer them an improved service based on past experience, the ability to innovate, and through the development of a culture of continuous improvement” (Egan, 2002).

![Figure 4-c: Type of relationships in the construction industry (Saad et al., 2002)](image-url)


Shrinking public market, growing private market
In accordance with the trend that clients want more integrated solutions (one-stop-shop supply) and clients trying to mobilise creativity at the market, the activities at the public market side are shrinking while activities at the private or supplying side are growing (figure 4-d). As design and engineering tasks were traditionally done at the client’s in-house engineering unit or at the consulting engineer hired by the client, nowadays more design tasks are being executed at the consulting engineer, hired by private contractors or contractors do design tasks at their in-house design units. New activities for consulting engineers have emerged like procurement/tendering consultancy and demand specifications, but this might be a temporary effect since these tasks will be the core business of a professional client.

![Figure 4-d: Shrinking public market, growing private market.](image)

Earlier market involvement in construction projects
As clients wish for integrated total solutions, the ‘pie’ is being awarded sooner and sooner. Traditionally, the ‘pie’ was shared between different parties during different stages of the construction process, nowadays the whole ‘pie’ gets awarded for the whole built facility. Consulting engineers face increased competition from entrants out of other industries like IT-companies, management consultants and accountancy companies.

In addition, the traditional role, being the client’s ‘right hand’, is threatened by the rise of highly specialised project management bureaus. Consulting engineers who have been forward integrating face competition from these management consultants, accountants and project management firms. Even project management itself is not new or unique anymore. The risk of commoditization of project management results in a tendency of these kinds of parties to get involved in projects even sooner.

Increasing standardisation, industrialisation and pre-fabrication
Through the last century, several attempts have been made to standardise construction, making buildings modular and making use of pre-fabricated parts, components or sub-systems. Massive breakthroughs of these concepts have still not taken place but the level of standardisation is still rising.

Examples of standardisation in transportation infrastructure in the Netherlands are the ‘bridge matrix’ and ‘roll pave’. The ‘bridge matrix’ offers a range of existing bridge types and components, sorted into categories. These include edgings, deck treatments and types of piers, railings and illumination. All of these are standardised and available in pre-fabricated form, in a variety of types, sizes and colours. Rollpave is a product co-development by the Dutch contractor Dura Vermeer Group and consultancy [www.allesoverbruggen.nl](http://www.allesoverbruggen.nl)

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11 [www.allesoverbruggen.nl](http://www.allesoverbruggen.nl)
and engineering company Intron. The rollpave concept is patented and provides a pre-fabricated unrollable (off-the roll) top layer asphalt.

**Sustainability**
International regulation, climate change, environmental awareness of clients and the society result in an increasing pressure to create social, environmental and economic value in construction projects.

**Globalisation**
Knowledge has become a ‘commodity’. Low-cost labour from east Europe or Asia can easily be acquired. Capacity is no longer a competitive advantage as it was for decades after the Second World War.

To conclude, table 4-a provides an overview of the changing construction industry.

<table>
<thead>
<tr>
<th>From:</th>
<th>To:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quantitative endeavor</td>
<td>Qualitative demand</td>
</tr>
<tr>
<td>Maximum efficiency</td>
<td>Maximum effectiveness</td>
</tr>
<tr>
<td>Functional specialization</td>
<td>Product/market specialization</td>
</tr>
<tr>
<td>Commodities</td>
<td>Specialties</td>
</tr>
<tr>
<td>Built facility focus</td>
<td>Customer focus</td>
</tr>
<tr>
<td>Disintegration problems</td>
<td>Integral (total) solution</td>
</tr>
<tr>
<td>Suppliers market</td>
<td>Buyers market</td>
</tr>
<tr>
<td>One-off project organization/collaboration</td>
<td>Strategic partnering</td>
</tr>
<tr>
<td>Lowest price</td>
<td>Value/costs ratio</td>
</tr>
<tr>
<td>Price competition</td>
<td>Knowledge competition</td>
</tr>
<tr>
<td>Competitive edge: Capacity</td>
<td>Competitive edge: Research &amp; Development</td>
</tr>
<tr>
<td>Scattered responsibilities</td>
<td>One focal point</td>
</tr>
<tr>
<td>Horizontal competition between consulting engineers</td>
<td>Vertical competition between supply chains/networks</td>
</tr>
<tr>
<td>Project/client specific concepts</td>
<td>Project independent concepts</td>
</tr>
<tr>
<td>One-of-a-kind (prototype-like)</td>
<td>Repetition, learning and continuous improvement</td>
</tr>
</tbody>
</table>

*Table 4-a: Overview of changing construction industry, adapted from Goslinga (2004).*
5. Theories and concepts for a supply-driven construction industry

This chapter discusses several theories that are used to construct a conceptual model of the supply-driven construction industry. The theories are selected based on their relevance to this research topic and for the purpose to provide an integrated perspective on the supply-driven construction industry. The conceptualization of the supply-driven construction industry is further explained in chapter 6.

5.1 Production-based versus economics-based construction theory

Koskela (2003) advocates a production-based approach to (construction) projects and argues that the theoretical field related to construction consists of three main parts:

- Conceptualization of peculiarities of construction as a special type of production: One-of-a-kind nature of projects, site production and temporary organizations.

Production dimension:
Three dominant concepts are identified in the theory of production. First, the production is viewed as a transformation of input to outputs. The second conceptualization views production as a flow, where in addition to transformation there are waiting, inspection and moving stages. The third conceptualization views production as a means for the fulfillment of customer needs (value generation).

The transformation concept was the mainstream industrial template of the 20th century. The flow concept is the underlying concept of just-in-time, lean production (and its newer variants, like mass-customization and agile manufacturing) and business process re-engineering.

The value generation concept is used for total quality management (TQM) and customer-oriented manufacturing. Consequently, as these three concepts are built upon each other and have generated additional performance, the ‘Transformation – Flow – Value generation’ conceptual framework (TFV) of production should be used simultaneously.

Management dimension:
The management of production may be divided into three constituent parts:
- Design of the production system
- Operation (planning, controlling and correcting) of the production system in order to get the intended production realized
- Improvement of the production system

The waste (non-value-adding activities) associated with the structure is determined at the time of the design of the system, and is thus tackled in advance. The waste associated with control is tackled during the production. The waste associated with the inherent nature of production (defects, variability etc.) is dealt with after the production. These three sources of waste evidently call for different methods.

Peculiarities:
There are many peculiarities found by several authors in literature that indicate why construction is different from other production industries. Koskela (2003) argues that the most important peculiarities can be clustered into three main categories: one-of-a-kind nature of projects, site production and temporary organizations.

Temporary organisations are common to other industries; in the paradigms of agility and virtual production short-term company cooperation for specific customer order is considered a very effective (future) production mode. Kornelius et al. (1998) even view the construction industry, with its virtual
organisations, as a learning case for other manufacturing industries. Though, it must not be overlooked that virtual organisations are formed on the basis of long term networks and that unlike construction, other manufacturing industries have evolved from a traditional customer-supplier relationships via supply management and supply chain management to (future) virtual organisations (Schönsleben, 2000).

This evolutionary process seen in other industries does not resemble the changes seen in construction. Therefore viewing the temporary organisations seen in construction as a learning case for other industries might be of limited value. In contrast, the construction industry might learn a lot from other manufacturing industries where a history of quality improvements, performance gains, trust, cooperation, information sharing, risk sharing and alliances are often found.

Koskela (2003) applied this theoretical base to the five main renewal initiatives found in construction (table 5.1-a). The intended benefits of industrialization in construction are: saving in manual labour on site, a faster construction process and a higher quality of components. The second renewal initiative attempts to create a fundamentally new organization for construction, like the ‘sequential procedure’ in France, ‘open building’ in the Netherlands or the ‘new building mode’ in Finland.

Third, great expectations have been attached to design-build procurement of construction projects, where the design and construction stages are integrated and contracted to one company. Fourth, also recommended by Latham (1994) and Egan (1998), partnering has been used as a generic term embracing a range of practices designed to promote greater cooperation. Finally, re-engineering (or business process re-engineering) refers to the radical reconfiguration of processes and tasks, especially with respect to implementation of IT.

<table>
<thead>
<tr>
<th>Renewal initiative</th>
<th>Theoretical interpretation</th>
<th>Theory of management</th>
<th>Treatment of peculiarities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Industrialization</td>
<td>Theory of production</td>
<td>Structural change to</td>
<td>Elimination of the</td>
</tr>
<tr>
<td>Comprehensive</td>
<td></td>
<td>the production system</td>
<td>peculiarity ‘site production’</td>
</tr>
<tr>
<td>organizational</td>
<td>Partial introduction of</td>
<td>Structural change to</td>
<td>Elimination or alleviation of</td>
</tr>
<tr>
<td>renewal</td>
<td>the flow and value</td>
<td>the production system</td>
<td>the peculiarities ‘one-of-a-kind’</td>
</tr>
<tr>
<td>Design-build</td>
<td>generation concepts</td>
<td></td>
<td>project’, ‘site production’,</td>
</tr>
<tr>
<td>Partnering</td>
<td>Introduction of some</td>
<td>Structural change to</td>
<td>‘temporary organization’</td>
</tr>
<tr>
<td></td>
<td>elements of the flow</td>
<td>the production system</td>
<td></td>
</tr>
<tr>
<td></td>
<td>concept</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Re-engineering</td>
<td>Introduction of some</td>
<td>Minor structural change to</td>
<td></td>
</tr>
<tr>
<td></td>
<td>elements of the flow</td>
<td>the production system;</td>
<td></td>
</tr>
<tr>
<td></td>
<td>concept</td>
<td>to some extent, improvement</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>of the production system</td>
<td></td>
</tr>
</tbody>
</table>

Table 5.1-a: Theoretical interpretation of renewal initiatives in construction (Koskela, 2003).

Koskela’s (2003) main conclusion is that these renewal initiatives have (partly) failed because the situation is only partially taken into consideration and not integrated. Most initiatives aim at eliminating or alleviating construction peculiarities, without realising that this has a price; new problems emerge. According to advocates of lean construction (production-based), project management theorists and practitioners (making use of PMI’s PMBoK\(^{12}\) and the ‘economics-based’ approach) have neglected the management of production and therefore, integration of the production perspective into project management theory and practice, is wished for (Koskela & Ballard, 2006).

\(^{12}\) Project Management Institute, Project Management Body of Knowledge.
The main critique that production-based theorists like Koskela have posted regarding the economics-based approach is:

- Focus on transactions (purchasing) rather than on production
- Focus on information flows rather than on material flows
- Places uncertainty reduction at the heart of the process
- Deploys a tectonic approach to organisation (neglecting the management functions of operations and improvements)

According to Winch (2006), lean construction theorists make an important distinction between ‘management-as-planning’ and ‘management-as-organising’; “Management-as-planning embodies the management approach where detailed planning is undertaken before structured implementation and control back against the original plan of any deviations during implementation. Crucially, the planner as an agent is seen as both omniscient and independent of the situation to be managed”. “Management-as-organizing embodies the approach where goals are set collaboratively and the details of implementation are both emergent as uncertainties are reduced and negotiated as differing perspectives are resolved. Here the manager as agent actively participates in the process being managed”.

Winch (2006) further argues that the critique, that PMBoK embodies the management-as-planning, is wrongful and that emphasizing on the differences between these theories of economics and production is not meaningful; both are needed.

As presented in table 5.1-b, Koskela & Ballard (2006) indicate some foundational differences underlying the economics-based approach represented by Winch’s ‘Managing construction projects (MCP): An information processing approach’ and the lean-construction’s production-based approach.

<table>
<thead>
<tr>
<th>Fundamental assumption on the nature of projects</th>
<th>Economics-based</th>
<th>Production-based</th>
</tr>
</thead>
<tbody>
<tr>
<td>Organizations integrated through transactions</td>
<td>production systems</td>
<td></td>
</tr>
<tr>
<td>Conceptualization of the project</td>
<td>Information-processing system</td>
<td>Transformation, flow value</td>
</tr>
<tr>
<td>Intrinsic goal</td>
<td>Uncertainty reduction (i.e. elimination of a lack of information)</td>
<td>Getting the facility produced, eliminating waste, increasing value</td>
</tr>
<tr>
<td>Nature of management</td>
<td>Creating the (contractual and organizational) structure</td>
<td>Designing, operating and improving the production system</td>
</tr>
</tbody>
</table>

Table 5.1-b: Comparison of the foundational issues of the economics- and production-based approaches to project management (Koskela & Ballard, 2006).

Customization and the customer order decoupling point (CODP):
Following section looks into different levels of customization and the concept of customer order decoupling point (CODP). In order to gain full understanding of ‘the supply-driven construction industry’, a little more theory about different levels of customization and different customer order decoupling points is necessary. One of the most important questions when looking into the concept of a supply-driven industry is ‘up to what level can construction objects be standardized and what level of customization is still required’?

An important distinction to make is the fact that in normal production systems the design is already ‘in place’ and production can only start when a design is finished. In construction, when a client traditionally places an order, this is first a design-order for the consulting engineer after which the production-order is directed to a supplier (contractor). Now, in a situation where design and construction (production) is the responsibility of only one party, in which that party also has the freedom to use its own creativeness and standardize up to a certain level, more understanding of design and production orders is needed.
The decoupling point separates that part of the supply chain geared towards directly satisfying customer orders from that part of the supply chain based on planning (Hoekstra & Romme, 1992). This point, at which real demand penetrates upstream in a supply chain, is the echelon at which the demand market ‘pull’ meets the supply-market ‘push’. Other terms used for this concept are the ‘order penetration point’, push-pull boundary or postponement boundary.

Wikner and Rudberg (2004) argue that a CODP separates decisions made under certainty from decisions made under uncertainty concerning customer demand. When customer demand fully penetrates upstream, the level of certainty is 100%. Since traditional construction projects are almost totally designed and engineered to customer requirements these demand orders typically penetrate very much upstream and consequently a high level of certainty.

![Image of productivity–flexibility trade-off and the positioning of the CODP](image)

In figure 5.1-a the productivity and flexibility forces are presented. The flexibility force (clients’ specific requirements) can be considered the market pull of the clients/customers. The productivity force can be considered the upstream push of producers in order to gain production efficiency (low-cost, standardized mass-production). The concept of mass customization is the situation where flexibility is remained while gaining production efficiency (low cost and client specific).

The positioning of the CODP in mass customization involves identifying the optimal balance between the productivity and flexibility forces. The further downstream in the value-adding material flow that the CODP is positioned, the higher the degree of emphasis on productivity in operations, therefore price (cost) is normally the major competitive priority. On the contrary, by positioning the CODP further upstream a company can achieve a higher degree of flexibility meeting customers’ specific requirements. As such, CODP’s are used to classify value-adding activities in terms of customer demand information, which in turn highlights the need for different management approaches depending on whether the activities are upstream or downstream of the decoupling point.

The production information flow (customer order signal) initiates and controls the materials flow through the life-cycle phases (concept, design, construction). The supply chain council uses three types of information penetration points, being engineer-to-order, make-to-order and make-to-stock/forecast (SCC, 2006). From a construction industry perspective, the ‘engineer-to-order’ can be divided into first concept-to-order and then design-to-order. As a result Winch (2003) determines the following four generic production strategies (see figure 5.1-b):

- Concept-to-order (CtO), where the customer (usually called a client in this context) enters at the start of the information flow – nothing happens until the client initiates production.
- Design-to-order (DtO), where the firm has already a basic product concept, but significant engineering design work is performed for that particular client/customer.
A supply-driven construction industry for transportation infrastructure

- Make-to-order (MtO), where there is a fully detailed design, which can be configured to suit a customer’s particular requirements (MtO/C) or where no additional design work needs to be done, but the materials flow does not start until the customer places an order.
- Make-to-forecast/stock (MtF), where the product is produced for stock and sold after it is manufactured or, sometimes, during manufacture.

A literature review by Rudberg and Wikner (2004) reveals that four CODP’s are most frequently used: engineer-to-order (EtO), make-to-order (MtO), assemble-to-order (AtO) and make-to-stock (MtS). The further downstream the CODP is positioned the more of the value-adding activities must be carried out under customer order uncertainty (speculation), and the further upstream the CODP is positioned the more activities can be based on customer order commitment, i.e. certain information (figure 5.1-c).

Rudberg and Wikner (2004) recognize that in the sequential approach, no difference is made between production- and engineering related activities. In order to integrate engineering resources with operational processes, they have developed a two dimensional approach (figure 5.1-d). The production dimension covers the traditional CODP’s related to the material flow (MtO, AtO and MtS).
A supply-driven construction industry for transportation infrastructure

The engineering dimension covers a continuum with two extremes. One extreme point in the engineering dimension is the situation when a new product (concept) is designed and engineered to order. The other extreme point in the engineering dimension depicts the situation when a product is designed before the enterprise faces actual customer demand, which could be interpreted as if the product design is already ‘in stock’.

Figure 5.1-d shows several pairs [engineering, production] representing different levels of customer involvement either in the engineering dimension or in the production dimension. The top-right triangle represents the area where CODP’s are not feasibility because of the constraint that engineering always precedes production. The lower-left triangle represents the area where CODP’s are feasible.

The CODP pair ‘ETS\textsubscript{ED} - MTS\textsubscript{PD}’ is an extreme point where both engineering and production activities are carried out without customer involvement (i.e. pure standardization). At the other extreme is the [ETO\textsubscript{ED}, MTO\textsubscript{PD}] where both engineering and production activities are performed according to customer specifications (i.e. pure customization) (Rudberg & Wikner, 2004).

**Key:**
- Engineering dimension:
  - ETO\textsubscript{ED}: Engineer-to-Order, engineering dimension.
  - ATO\textsubscript{ED}: Adapt-to-Order, engineering dimension.
  - ETS\textsubscript{ED}: Engineer-to-Stock, engineering dimension.
- Production dimension:
  - MTO\textsubscript{PD}: Make-to-Order, production dimension.
  - ATO\textsubscript{PD}: Assemble-to-Order, production dimension.
  - MTS\textsubscript{PD}: Make-to-Stock, production dimension.

Figure 5.1-d: The two-dimensional CODP space (Rudberg & Wikner, 2004).

As a supply-driven construction industry implies a shift from the traditional position of engineer-to-order (engineering dimension) towards adapt-to-order and engineer-to-stock, this two-dimensional approach is very useful for analyzing construction projects and organizations. Combining figure 5.1-b...
with the two-dimensional approach proposed by Rudberg and Wikners gives figure 5.1-e where the
ingineering dimension represents the concept/design phase in construction and the production
dimension represents the realization phase in construction.

How does the model as depicted in figure 5.1-e apply to construction regarding different types of
construction markets? Although in the private housing industry some evidence is found (in Japan) of
the production models of make-to-order and make-to-forecast (stock) production, the buildings and
major projects markets are traditionally dominated by the concept-to-order strategy. Here design
consultants are being hired to undertake design, before going to the execution phase based on a
competitive tender.

![Diagram of construction industry models](image)

**Figure 5.1-e: Customer-order decoupling points in construction, adapted from Winch (2003).**

The first step towards a supply-driven construction industry is to move from the concept-to-order
strategy towards a design-to-order strategy, where system integrators offer modularised solutions
engineered to meet client’s particular needs (on a turn-key basis). A second step towards a supply-
driven industry is to push further from the design-to-order to the make-to-order strategy. Winch (2003)
argues that this is probably viable for certain standardised building types where branding is important
across a chain such as fast-food chains or hotel chains, or other building types where the required
functionality does not differ significantly between locations, such as retail units, schools and prisons.

The procurement of major projects like infrastructure projects has traditionally been based on the
concept-to-order strategy. The rationale is that a CtO-strategy has important risk management
properties as the tender process provides an important natural review point after concept and design
development. Relatively low costs are incurred at that point of review and if risks remain too high,
cancellation is easy. It seems plausible that due to the inherent one-off nature of major projects,
procurement based on a DtO-strategy is unlikely to be viable.

Nevertheless, as major projects in total are always dedicated, unique and one-of-a-kind (especially
looking at the unique geographical fit-in of major projects), sub-systems of major projects might be
suitable for a supply-driven approach. Especially where clients are willing to accept much greater
simplicity and standardisation in their new construction, a DiO-strategy might be viable. Moreover,
looking at the sub-sector of transportation infrastructure projects for instance motorways, railways,
bridges, fly-over etc. do not differ very much in functionality between locations.
Chapter 4 mentioned the ‘bridge matrix’ and ‘rollpave’ as examples of make-to-order (configure-to-order) production on sub-system level in civil engineering. Advantages of industrialisation (prefab) are decreased construction time, lower construction costs (economies of scale), tested and validated products, and less inconvenience for the local neighbourhood. Disadvantages found in literature were a longer error correction cycle and higher requirements for dimensional accuracy (Koskela, 2003).

To conclude, construction theorists do not yet agree upon a common theory of construction. Nevertheless, it is important to recap some important theoretical features of construction in order to be able to describe the supply-driven construction industry in chapter 6.

In general, the material supply chain in construction starts with element suppliers and raw material suppliers and is fully geared towards a fixed construction site. Therefore, one can distinguish between the supply chain itself and the construction site where the realization takes place. As mentioned, several initiatives have been taken in order to shift activities from the construction site to the supply chain. This is what is referred to as pre-fabrication, industrialisation or modularization.

Besides the material flow, also the information flow has an important role in construction with respect to the level of customization. A distinction can be made between the engineering dimension and the production dimension. The production dimension concerns the actual material flows in construction supply chains. It is clear that a trend towards more pre-fabrication would imply a shift from a make-to-order production system towards an assemble-to-order production system. From the engineering perspective, construction objects can range from fully client order specific (concept-to-order) to ‘off the shelf’ designs (design-to-stock).

Looking at supply chain management in construction, Vrijhoef and Koskela (2000) distinguish four roles (figure 5.1-f). The first role focuses on the interface between the supply chain and the construction site. The contractor, whose main interest is in site activities (avoidance of on-site workflow), is in the best position to adopt this focus. The second role focuses on the supply chain itself (lead-time, inventory). Here material and component suppliers may adopt this focus as well as contractors.

The third role focuses on transferring activities from construction site to the supply chain. The two examples ‘rollpave’ and ‘bridge matrix’ mentioned before are typical examples of transferring activities from the site to the supply chain. Suppliers or contractors may initiate this focus. The fourth and last role focuses on the integrated management of the supply chain and the construction site. This most elaborate role may be initiated by clients, suppliers or contractors.

Figure 5.1-f: The four roles of supply chain management in construction (Vrijhoef & Koskela, 2000).
5.2 Organization theory

Henry Mintzberg (1983) identifies five main configurations (archetypes) of organizations, five main parts of organizations and five types of coordination mechanisms, which can be related as presented in Table 5.2.

<table>
<thead>
<tr>
<th>Organization configuration</th>
<th>Simple structure</th>
<th>Machine bureaucracy</th>
<th>Professional bureaucracy</th>
<th>Divisional form</th>
<th>Adhocracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary coordination mechanism</td>
<td>Direct supervision</td>
<td>Standardization of work processes</td>
<td>Standardization of skills</td>
<td>Standardization of output</td>
<td>Mutual adjustment</td>
</tr>
<tr>
<td>Main part of the organization</td>
<td>Strategic apex</td>
<td>Technostructure</td>
<td>Operating core</td>
<td>Middle line</td>
<td>Support staff and operating core</td>
</tr>
</tbody>
</table>

Table 5.2: Five organization configurations, coordination mechanisms and main parts of the organization (Mintzberg, 1983).

Construction organisations (contractors) tend to resemble the machine bureaucracy, divisional form and to a limited extent the professional bureaucracy type of organizations. Construction realization generally involves detailed work procedures and standard work methods, which resembles the machine bureaucracy (standardization of work processes). Main contractors are mostly large conglomerates of divisions controlled by a central management at the headquarter, which resembles the divisional form (standardization of outputs). Furthermore, specialized construction workers are also sometimes highly trained or skilled, which resembles the professional bureaucracy (standardization of skills).

On the other hand, consultancy and engineering firms tend to resemble the organisational configurations of adhocracy (mutual adjustment) and professional bureaucracy (standardisation of skills). The adhocracy is a very organic structure with very little behaviour formalization. Jobs are highly specialized horizontally, and the employees are professionals. Contrary to the other organizational configurations, large parts of the organization are organized into ad hoc project teams that execute specific projects.

Several subtypes of the adhocracy exist, but the two most dominant are the operating adhocracy and the administrative adhocracy. The operating adhocracy is characterized by a very large and very important operating core. Here client-based problems are solved, and typically, the administrative and operative work blends in a single effort. This somewhat resembles the professional bureaucracy as it relies on its specialists (skills). The administrative adhocracy undertakes projects just to serve itself. Different from the operating adhocracy, this configuration keeps a sharp distinction between the operating core and the administrative component. One example of the administrative adhocracy is NASA’s Apollo-project where NASA did a lot of in-house research and development, but outsourced the production.

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13 In Dutch: Operationele adhocratie.
14 In Dutch: Bestuurlijke adhocratie.
Figure 5.2-a illustrates the essence of several of Mintzberg’s hypotheses. Namely how the different coordinating mechanisms thrive under different environmental circumstances. The more complex the environment is, the more decentralized the structure will be. In addition, in dynamic environments, organizations tend to be more organic.

Figure 5.2-a also depicts the area of coordination mechanisms most likely to be found in either construction organizations or consultancy and engineering organizations. It is important to consider the differences between construction and consultancy when taking a supply chain perspective. As supply chains in construction are getting more and more integrated, a clash of different cultures can be expected. When a contractor and a consulting engineer start up a joint venture or a temporary ‘special purpose vehicle’, coordination mechanisms used at the contractor obviously hampers effective consultancy and engineering, while coordination mechanisms used in consultancy and engineering obviously hampers effective production (construction).

Interesting to note is that such a mix of coordination mechanisms can be effectively combined in the administrative adhocracy configuration. The production (construction) function located in the operating core is loosely coupled or even outsourced and thereby able to function as a machine bureaucracy while the administrative part of the organization can still function in a flexible, organic and innovative manner. The administrative part refers to a meltage of middle line, support staff, technostructure and even the strategic apex is partly sunk into the administrative part. In the administrative adhocracy, strategy does not seem to be deliberately formed by certain individuals, but is rather an emergent and implicit process.

Different organizational configurations also influence the level of innovation. Innovation is unlikely to be expected in a machine bureaucracy, where the adhocracy is very fit for innovations. Koskela and Vrijhoef (2001) argue that the current theory of construction is one root cause for low innovation activity in construction. They call for an explicit and more powerful theory of construction that is needed for further innovation, which is ‘to manage new ideas into good currency’. A deficient and implicit theory of production in construction hampers radical managerial innovation, top-down innovation and bottom-up innovation (figure 5.2-b).
A radical innovation is based on a breakthrough in science or technology and changes the character of the industry itself. Radical innovation is the most elaborate and powerful form of innovation and can for instance be related to new materials (technology) or supply-driven procurement (science/managerial).

Winch (1998) recognizes that, unlike many other industries, innovations in construction are typically not implemented within the firm itself, but on the projects upon which the firm is engaged. Regarding bottom-up innovation, projects typically have a fragmented, outsourced (sub-contracted) and ad-hoc type of organisation and as a result, whatever problem solving goes on, remains outside the firm (no learning).

On the institutional level, Winch (1998) distinguishes, based on other complex systems industries, between innovation superstructure and innovation infrastructure (figure 5.2-d). Complex systems industries create complex product systems that are characterised by:

- Many interconnected and customised elements organised in a hierarchical way
- Non-linear and continuously emerging properties where small changes to one element of the system can lead to large changes elsewhere in the system
- A high degree of user involvement in the innovation process
The innovation superstructure consists of clients, regulators and professional institutions (construction research organisations). The innovation infrastructure consists of trade contractors (specialized suppliers), specialist consultants and component suppliers. The interface between the two is the role of system integrators whose role is shared between the principal architect/consulting-engineer and principal contractor.

Furthermore, Winch (1998) points that innovation dynamics can be stifled either by an exploitation trap where the system is institutionally locked into particular technologies as in Sweden, and the exploration trap where technologies are continually re-invented in a circular rather than progressive manner as in Denmark, England or the Netherlands.

Vrijhoef and De Ridder (2005; 2006) recognize the need to integrate both demand and supply systems in order to align the large number of parties involved and gain effectiveness and efficiency benefits. Integration depends on the strength of the relationship between members of the supply chain, and whether the relationship is short or long term (Schönsleben, 2000). Supply chain integration is not a goal in itself: it is aimed at increasing profitability and competitive strength of suppliers as well as increasing client value, and as a result increasing common socio-economic benefit of construction works in general (Vrijhoef & De Ridder, 2005). Two new central roles are introduced: the demand system integrator and the supply system integrator. Demand system integrators might be represented by clients, supply system integrators might be represented by main contractors or (large) consultancy and engineering companies.

Clients, especially those with ‘buying power’ like Rijkswaterstaat in the Netherlands, are often the dominant factor in procurement strategies and consequently the success of supply chain integration. A lack of continuity of relationships hinders gaining the full advantages of long-term collaboration and transfer of experience and knowledge across projects (Bresnen & Marshall, 2000). From the perspective of construction clients, client-driven supply integration must be based on the fact that all clients’ clients (users, stakeholders) are somehow included in the demand (Vrijhoef & De Ridder, 2005).

At the supply side, independently from demand, parties may evolve towards more integrated production and business formats, through project-independent collaboration with other parties (Vrijhoef & De Ridder, 2006). From the supply chain perspective, many contractors/suppliers have redefined their businesses based on the clients’ altered procurement methods, but apart from that, also altered their businesses based on own strategic change to move away from project delivery towards integrated product development (Vrijhoef & De Ridder, 2005).
5.3 Value chain theory

According to Michael Porter (1985), the value chain disaggregates a firm into its strategically relevant activities in order to understand the behavior of costs and the existing and potential sources of differentiation and thus competitive advantage. Figure 5.3-a presents a firm’s generic value chain consisting of value activities and margin. Value activities consist of primary activities and support services. A firm’s value chain is part of a value system (supply chain) that is part of a network of value systems (supply networks).

In accordance with Porter’s (1985) notion of the value chain, the demand chain makes up a network of value demanding parties (clients, owners, users, etc.) and the supply chain makes up a network of value supplying parties (contractors, suppliers, consulting engineers etc.).

![Figure 5.3-a: The generic value chain (Porter, 1985).](attachment:image.png)

Value chains may differ in scope between competitors and thereby represent a potential source of competitive advantage. Firms can choose to limit their services only to a certain market segment (niche) so their value chain is tailored to that particular segment offering either lower cost or differentiation. Another difference occurs when firms narrow or broaden their geographical markets. A third difference between competitors value chains and thus a source for competitive advantage is through interrelationships. A firm may exploit the benefits of broader scope internally or it may form coalitions with other firms to do so. Coalitions are long-term alliances (strategic partnering) with other firms like joint ventures, shared R&D, supply agreements etc.

Looking at consulting engineers, the competitive advantage can be achieved through the scope of their value chains in terms of market segments and types of services (see figure 5.3-b). Small autonomous firms who offer highly specialized services are expected to stay small as long as they aim to be autonomous since they will never be able to serve a great share of the markets segments and services. Larger assignments always require multidisciplinary approaches and knowledge and only larger consultancy and engineering firms are able to deliver that scope. In order to achieve a competitive advantage compared to competitors consulting engineers are broadening (integrating) their scope of services into project management, facility management, financial services. In response to the client’s wish for ‘one-stop-shop’ procurement, consulting engineers increasingly act as ‘prime contractor’ or turnkey-contractor in order to gain a competitive advantage.

Consulting engineers can also broaden their scope of services through strategic partnering. Consultancy and engineering firms might for instance set up joint ventures with contractors (DHV & BAM in ‘schoolcompagnie’) or research alliances with technological institutions (DHV & TU Delft in ‘Nereda’).
Regarding a business strategy, Porter notes that a company can outperform rivals only if it can establish a difference that it can preserve. The essence of strategy is choosing to perform activities differently than rivals do. Strategic positions can be based on customers' needs, customers' accessibility, or the variety of a company's products or services. Trade-offs are essential to strategy. They create the need for choice and purposefully limit what a company offers.

Due to the highly customized and demand-driven nature of construction, there is little room for trade-offs at the market (contractors / consulting engineers). This is shown by the fact that contractors or consulting engineers are generally able to offer the same services. In a demand-driven industry, capacity and lowest price are the main competitive advantages. On the other hand, a supply-driven construction industry implies room for trade-offs and strategic positioning. Here, quality, innovation and customer satisfaction are competitive advantages.
5.4 The Living Building Concept

The basic idea of the living building concept is that the construction chain needs to be turned around. Instead of mobilizing creativity in demand, creativity should be mobilized in supply (De Ridder, 2006). The traditional role of the client and his ‘right hand’ the consulting engineer needs to change. This traditional role is expressed in determining in advance what is needed for the end-users over a long range of time and consequently also in determining what the suppliers/contractors should build this (one) time. The system needs to change from a three-party organization (see figure 1-a) to a two-party organization. In this system the demander is the client as value consumer and the supplier is the contractor (consortium) as value producer.

The focus is extended beyond project delivery only towards built services over a life cycle with dynamic control of the benefit (value minus costs) in order to deal with perception. The problem of perception is that the demand and the fact that the first demand is basically always incorrect or incomplete, while it is impossible to demand before knowing what is available and possible, nor is supplying without knowing on a basic level what is wanted (De Ridder & Vrijhoef, 2005).

Procurement will not be based on fixed briefs and solutions of the client, to be built by the supplier with the lowest price. Instead the client will put a solution space into the market where the market is encouraged to come with solutions and the client chooses the proposal with the maximum benefit (value minus price). As technologies, problems, whishes, desires and requirements change over time, construction objects need to change from a product-orientation to a process-orientation. Construction objects need to be ‘fit-for-purpose’ and ‘up-to-date’ over its whole life cycle and this requires adaptability and a change from (temporary) project management to (continuous) process management.

The contract will not prescribe an absolute performance output against a fixed price, but rather define an agreed-upon performance-price (value minus costs) balance. Within a “performance related partnering” arrangement the process can then be dynamically controlled; clients can alter their initial demand and calculate the impact on the initial price, and vice versa supplying parties are enabled to come up with new solutions that may reduce costs, or deliver additional performance output increasing client value.

Dynamic control means that the client’s budget needs to include a buffer for dynamic control by the client. The supplier (e.g. contractor) sets an initial price for a basic solution to meet the client’s initial wishes. The buffer between the budget and the price is used for unforeseen changes and change orders; changing demands, requirements, regulations, standards, technology, finance etc. (De Ridder & Vrijhoef, 2005).

Finally, also branding and marketing must be introduced for a successful Living Building Concept. Where suppliers (contractors and consulting engineers) are currently all able to do the same with interchangeable sub-contractors, in the future suppliers build up long term networks of partners, making trade-offs (branding), watching trends and focussing on end-user demands.
5.5 Summary

This chapter shows that several attempts have been taken to eliminate one or more of the important peculiarities of the construction industry, being 'site production', 'one-of-a-kind projects' and 'temporary organization'. It is important towards a conceptual model of a supply-driven construction industry, to know how these peculiarities may be managed for this industry to become more efficient.

The logistical concept of ‘customer-order-decoupling-point’ was introduced to characterize the construction industry in terms of the level of customization and standardization. Material standardization can alleviate the peculiarity ‘site production’, as components, elements and subsystems are produced in a more industrial manner. On the other hand, due to the characteristic of transportation infrastructure projects being irreversibly sunk (resource intensive), this sector can never be physically standardized in terms of ‘of-the-shelf’ products. Nevertheless, conceptual standardization can alleviate the peculiarity ‘one-of-a-kind project’, as families of concepts and designs can be adapted and used repetitively. The current construction industry can be characterized as being close to pure customization; projects are initiated and developed almost fully client specific.

In the supply-driven construction industry, a responsive pull market with a high level of client interference is replaced by a proactive push market with less client interference. From a conceptual perspective, a supply-driven construction industry implies that concepts or designs are less client-specific and more pre-engineered.

Inherent to a lower level of client interference in the supply-driven construction industry, organizations have to become less project-based (organization shaped by projects) and more functional. This means a less responsive focus (outside-in) and a more proactive focus (inside-out). The exploration trap inherent to project-based, prototype-like industries will be replaced by innovation and continuous improvement adopted on firms level rather than on project level.

As the organizational culture and coordination mechanisms are rather different for the engineering dimension (consultancy and engineering) compared to the production dimension (contractors, suppliers) in construction, these functions need to be combined effectively. Where consultancy and engineering involves creativity, professionalism and mutual adjustment, production (realization) involves efficiency, capacity and standardization of work processes.

As a source of competitive advantage firms in the supply chain from concept up to realization (and possibly maintenance and operation) can form interrelationships (strategic partnering). For a supply-driven construction industry it is essential to form long-term relationships which enables repetition, learning and continuous improvement between partners. Proactive total solution providers with a life-cycle perspective may outperform rivals as they can offer more value added (integrated services) at lower costs compared to rivals.
6. A view on the supply-driven construction industry

This chapter gives a conceptual view on the supply-driven construction industry and is based on the combination and integration of theoretical findings as presented in chapter 5.

6.1 Elaboration on the supply-driven construction industry

The supply-driven construction industry is a market situation that is no longer a top-down demand-driven suppliers market, but instead a bottom-up supply-driven customer-oriented buyers market. These differences are depicted in figure 6.1-a. The traditional demand-driven construction industry is characterised by the concept-to-order production strategy where the supply-driven construction industry is characterised by a shift from the concept-to-order strategy towards adapt-design-to-order or configure-to-order strategies.

This means the clients will no longer fully specify their demand in advance, but instead specify a solution space based on requirements and wishes. Suppliers (contractors, consulting engineers) will no longer take a responsive (reactive) position regarding market demand, but instead shift to a proactive position. Since suppliers (contractors/consulting engineers) in the traditional demand-driven system all passively wait for client-orders (fully specified demand), they all offer generally the same (capacity). In the supply-driven system, suppliers purposefully limit what they offer depending on what they are good at and where they can have superior performance and profits. This implies a shift from functional specialisation to product/market specialisation.

Clients’ shift from an efficiency focus to an effectiveness focus results in the fact that research and development is being rewarded. Suppliers can either choose to do R&D themselves or set up joint R&D ventures. Concepts and products get a repetitive character as these are being developed in a project independent manner (independent from a specific client-order). Repetitive implementation of concepts or products means that learning and continuous improvement get a chance.

Parties will look for strategic partnering in order to remain competitive and offer value added to their clients. Supplying parties will have to do research and development based on complex and balanced societal needs and thus client demand. The focus will shift from a built facility focus to a customer focus in order to provide value added. Responsibilities will be located at one focal point and the supplier will provide integrated solutions. These integrated solutions can be configured or adapted for every client’s specific requirements.

A growing need for suppliers to provide more than basic physical products, being value-added services to support components and systems needed to assist clients and users in operating, maintaining and adapting buildings and structures, results in project-based, service enhanced firms with an extended focus on life cycle value delivery for the client.
Supply chains will become integrated and aligned based on long-term cooperation between supply chain members. Competition will change from traditional ‘horizontal’ and ‘vertical’ competition within a supply chain to ‘horizontal’ competition between supply chains or adaptive networks of cooperating supplying parties. This change is shown in figure 6.1-b. Like in ‘buyers markets’, suppliers will build-up a virtual ‘shop window’ or catalogue, where they offer a range of products or concepts. This range of products might be an industrial manufactured product family. The change of

**Demand-driven construction industry:**

‘horizontal’ and ‘vertical’ competition within the supply chain

**Supply-driven construction industry:**

‘horizontal’ competition between ‘vertically’ integrated supply chains

Products or concepts are no longer fully specified by the demander, but instead for a large share specified by the suppliers who developed it. This means that in the new situation the suppliers surprise the clients, whereas in the demand-driven situation the suppliers were surprised by the demand of the clients.

Marketing and branding will be an important feature of the supply-driven construction industry. It is likely that suppliers will position themselves differently and create different brands and images. Some suppliers might position themselves as low-cost no-frills suppliers serving clients who want relatively standardized and proven products. Other suppliers might position themselves based on competitive
advantages like reliability, lead-time (speed), aesthetics (beauty), sustainability (environmental friendliness) or flexibility. The supply-driven construction industry will better reflect the variety of its clients’ base.

Figure 6.1-c depicts the supply-driven construction industry in terms of customization and standardization. As the demand-driven construction industry is characterized as being close to pure customization, the supply-driven construction industry will shift towards less client specific concepts and designs. Paragraph 2.4 mentioned that large infrastructure projects are very resource intensive and always need to fit into the physical environment. Therefore, it is impossible to fully standardize construction like buying infrastructure off the shelf. Nevertheless, it is possible to develop concepts and designs in a client-independent and project-independent manner. This means that supplying parties will develop pre-engineered concepts and designs, which are virtually available. The client (or supplier on behalf of the client) can configure and customize it to its particular needs.

The interference of the client will be lower than in the traditional situation, because concepts/designs are standardized on a higher level than elements and components. Supplying parties will spend maybe years of R&D effort into this concept/product development, which may be patented, certified and accompanied with a guarantee.

As product development and innovation become important competitive advantages in the supply-driven construction industry, figure 5.2-c has been adapted into figure 6.1-d. This new figure depicts the firm’s environment and in this case research and development as a source of generating new ideas (invention). This might be a formal R&D program of the firm itself or a joint R&D effort led by a systems integrator. Research and development activities must be linked with market demand by means of market research. Market research involves assessing and screening current and future societal/market issues, trends and needs.

New ideas, concepts, products and processes have to be adopted by the firm and implemented on projects in order to innovate. Actual implementation during projects at the construction site is generally a trial and error process where problem solving takes place. Through problem solving on the projects, firms can learn and make incremental improvements as the ideas are being implemented repetitively.
This cycle of adoption $\rightarrow$ implementation $\rightarrow$ problem solving $\rightarrow$ learning, induces a process of continuous improvement.

Management of innovation: Managing new ideas into good currency

Figure 6.1-d: A model of non client-order-driven construction innovation processes, adapted from Winch (1998).

It is important to note that the management of innovation involves managing new ideas into good currency. The activity of invention (generating new ideas) generally involves ‘technical champions’, while the management of innovation involves ‘business champions’ and ‘executive champions’. The term ‘champion’ refers to the individuals who lead the innovation process.

Three types of champions can be identified who work together. First, ‘the technical champion’ who carries an idea from the initial concept through to development into a viable product or process. In addition, ‘the business champion’ who provides a business framework for a technical idea and last ‘the executive champion’ who sponsors the idea at the highest level, using his/her power to protect it, move it along and seize the opportunity to exploit it (Arthur D. Little Inc. 1985, p. 36). Nam and Tatum (1997) note that while it is not yet known whether entrepreneurs or champions are born, developed or the results of serendipity and circumstance, it is certain that the function of the champion must be linked with the entrepreneurial function. This includes risk taking, the provision of capital, the development from idea or prototype to operational status and the coupling of the market place with the inventor’s concept.

Looking from an organizational perspective, one can identify a continuum of organizational forms ranging from pure functional to pure project-based (Hobday, 2000). The functional organization refers to Mintzberg’s machine bureaucracy and divisional forms as described in chapter 5.2, characterized by clear separation between functional departments. The project-based organization refers to Mintzberg’s adhocracy as described in chapter 5.2, characterized by ad-hoc multidisciplinary teams.

The project-based organization is able to cope with emerging properties in production and respond flexibly to changing client needs. It is also effective at integrating different types of knowledge and skills and coping with the project risks and uncertainties common in complex products and systems industries like large infrastructure projects. However, the project-based organisation is inherently weak where the functional/matrix organisation is strong: in performing routine tasks, achieving economies of scale, coordinating cross-project resources, facilitating company wide technical development, and promoting organisation-wide learning (Hobday, 2000).
Obviously, different types of organizational forms have their strengths and weaknesses in different environments. As construction firms were traditionally constructing based on fully detailed specifications, in the supply-driven construction industry these firms perform R&D activities (invention), implementation of new ideas (innovation) and learning from on-project problem solving. As business processes on firm level are ongoing and repetitive, and project processes have a tendency to be temporary and unique, to be successful, firms need to integrate the experiences of projects into their continuous business processes in order to ensure the coherence of the organisation.

Consultancy and engineering firms who traditionally mainly work on hours fees basis (effort-based) for their external clients and have limited central functions, will shift back from the pure project-based towards the project-led organisation\textsuperscript{15} in the supply-driven construction industry. This strategy will stimulate organisational learning and provide incentives and resources for greater technical leadership. In other words, as parties are proactively developing concepts and designs based on expected customer needs (demand oriented), they will change from a capacity facilitator like in the operational adhocracy towards a proactively developing and self-serving organization, like in the administrative adhocracy. Proactive consultancy and engineering firms will have to step away from pure client-order-based activities and develop concepts based on market research, R&D, multi-disciplinary in-house top experts or through partnerships.

As concepts and designs or products and services are being repetitively implemented, this means products will follow a product life cycle as in normal industries; introduction $\rightarrow$ growth $\rightarrow$ maturity $\rightarrow$ saturation $\rightarrow$ decline. Obviously, the project-led organizational form is most fit for the volatile, complex and dynamic introduction phase of a concept/product where invention and first implementation takes place in a very uncertain environment. When product processes are more proven and routine, the functional organisation is most fit.

The administrative adhocracy is able to combine a highly flexible adhocratic part with a more rigid and routine production part of the organization. Moreover, there are still several options for strategic positioning for consulting engineers (consultancy and engineering) and construction firms. These possible positions will be elaborated in the next two paragraphs. An overview of differences between the demand-driven and supply-driven construction industry is presented in table 6.1-a.

\begin{table}[h]
\begin{center}
\begin{tabular}{|l|l|}
\hline
\textbf{Demand-driven:} & \textbf{Supply-driven:} \\
\hline
Responsive supply (pull market) & Proactive supply (push market) \\
Creativity in demand & Creativity in supply \\
Concept-to-order & Adapt/configure-to-order \\
Functional specialization & Product/market specialization \\
Commodities & Specialties \\
Built facility focus & Customer focus \\
Disintegration problems & Integral (total) solution \\
One-off project organization/collaboration & Strategic partnering \\
Price competition & Knowledge competition \\
Competitive advantage: Capacity & Competitive advantage: (Market) Research and Development \\
Scattered responsibilities & One focal point \\
Competition within supply chains & Competition between supply chains \\
Project/client specific concepts and innovations & Project independent concepts and innovations \\
One-of-a-kind (prototype-like) & Repetition, learning and continuous improvement \\
You ask, we design or build & We design and/or build, you choose (adapt/configure) \\
No marketing and branding & Marketing and branding \\
No concept/product families & Concept/Product families \\
Supplier surprised by demand & Demander surprised by supply \\
\hline
\end{tabular}
\end{center}
\caption{Overview of the differences between demand-driven and supply-driven construction industry.}
\end{table}

\textsuperscript{15} Project-led organization is adopted from Hobday, 2000. The project-led organization is a modified form of the pure project-based organization, thus more functional than the pure project-based organization.
The right triangle in figure 6.1-e depicts the model of the supply-driven construction industry (LBC\textsuperscript{16} ‘push market’). The level of standardization is increased from the elements and components level to the subsystems level. Furthermore, it shows that a large effort in pre-contractual tendering work will no longer be necessary as suppliers (contractors / consortia) offer a product family of virtually pre-engineered and standardized concepts and products that are ready to be implemented for specific clients’ problems. The concept or product can be adapted to client specific wishes in a relatively short amount of time. Every supplier will have its strategic trade-offs and product-market combinations.

An example of subsystems in transportation infrastructure systems could be roads, including subsystems such as asphalt paving, safety measures and road signaling systems. Those subsystems can be subdivided into multiple components, such as road foundation, asphalt, lineation, crash barriers, signage etc. Following the rules of systems engineering the process of subdivision can go on for few more stages until one arrives at the level of bolts and screws. For instance, the development of supplier specific product families could be the whole installation of roadways per kilometer, including road signaling, noise reducing measures, communications etc. In addition, suppliers could decide to offer totally integrated solutions based on strategic trade-offs, new developments in society or when entering specific niche markets, such as low-cost roadways, zero-emission roadways, reduced noise roadways, tunneled roadway systems or intelligent roadways including intelligent transport systems (ITS).

\textsuperscript{16} LBC = Living Building Concept (De Ridder, 2006)
6.2 Implications for consulting engineers

Traditionally consultancy and engineering firms are the ‘right hand’ of the client. They provide specialist consultancy or engineering services or act as delegated (public) client. As more engineering tasks are being transferred towards contractors in design-build contacts, consulting engineers are increasingly involved in contractor’s proposals. As the supply-driven construction industry not only implies earlier contractual market involvement as in DB+ contracts, but also concept/product development at the market-side, consultancy and engineering firms are confronted with more dispersed possible positions. An overview of differences between the demand-driven and supply-driven industry for consulting engineers is presented in table 6.2-a.

<table>
<thead>
<tr>
<th>Demand-driven consultancy and engineering</th>
<th>Supply-driven consultancy and engineering</th>
</tr>
</thead>
<tbody>
<tr>
<td>Responsive services (pull market)</td>
<td>Proactive services (push market)</td>
</tr>
<tr>
<td>Supplying fragmented services and knowledge to clients (manpower)</td>
<td>Developing and supplying innovative solutions (R&amp;D, innovation, system integration)</td>
</tr>
<tr>
<td>Clients’ right hand</td>
<td>Partner, developer, integrator or specialist consultant</td>
</tr>
<tr>
<td>Horizontal competition (between consulting engineers)</td>
<td>Horizontal and vertical competition (between integrated supply chains with total solution providers)</td>
</tr>
<tr>
<td>Delivering manpower and expertise wherever needed</td>
<td>Strategic trade-offs</td>
</tr>
<tr>
<td>Low risk (effort-based obligations)</td>
<td>Higher risk (result-based obligations)</td>
</tr>
</tbody>
</table>

Table 6.2-a: Overview of the differences between demand-driven and supply-driven consultancy & engineering.

The distinction between consultancy and engineering firms, contractors, component suppliers, element suppliers and project developers, will increasingly become harder. Some contractors will become project developers; other contractors remain traditional construction firms. Consulting engineers might become project developers, partner in consortia, engineering contractors, knowledge and technology brokers, system integrators or remain traditional hours-fees specialist consultants.

Increasing involvement by the innovator in commercialization

<table>
<thead>
<tr>
<th>Risk and return</th>
<th>Licensing</th>
<th>Outsourcing certain functions</th>
<th>Strategic alliance</th>
<th>Joint venture</th>
<th>Internal commercialisation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Risk and return</td>
<td>Licensing</td>
<td>Outsourcing certain functions</td>
<td>Strategic alliance</td>
<td>Joint venture</td>
<td>Internal commercialisation</td>
</tr>
<tr>
<td>Very small investment risk, but returns also limited (unless patent position very strong)</td>
<td>Limits capital investment, but may create dependence on suppliers/partners</td>
<td>Benefits of flexibility, risks of informal structure</td>
<td>Shares investment and risk, Risk of partner disagreement and culture clash</td>
<td>Biggest investment requirement and corresponding risks, Benefits of control</td>
<td></td>
</tr>
<tr>
<td>Some legal risks</td>
<td>Few</td>
<td>Permits accessing of outside resources and capabilities</td>
<td>Permits pooling of the resources and capabilities of more than one firm</td>
<td>Substantial requirements in terms of finance, production capability, marketing capability distribution etc.</td>
<td></td>
</tr>
</tbody>
</table>

Table 6.2-b: Alternative strategies for exploiting innovation (Grant 2002, pp.342).

Innovation and systems integration will become very important for consulting engineers in the supply-driven construction industry. Research and development activities must be linked with market research on societal/market needs and trends. Consulting engineers can gain an important function as systems
integrator between on the one hand the clients, society, professional institutions (universities) and regulators, and on the other hand the supplying industry being specialist suppliers, component suppliers, element suppliers or specialist consultants.

As mentioned before, innovations need to be managed into good currency. There is a range of alternative strategies to exploit innovations. Table 6.2-b presents this range of strategies to exploit innovations. Licensing is the least risky option, where internal commercialisation involves most risks. Inherent to a higher risk profile is that this also offers higher (potential) returns.

In the new market situation, supply chain members can have different roles. Organisations can be a ‘driving force’ for innovation as supply chain leader. Key individuals in the ‘driving force’ type of organization carry ideas from conception through to development into a viable process or product. They persuade other organizations to participate in the project and lead the innovation process (Nam & Tatum, 1997). On the other hand, organisations can also be a ‘technical collaborator’ as a collaborative supply chain member (partner). Upon receiving the initiative from the driving force, members of the ‘technical collaborator’ type of organizations provide technical expertise for the innovation process (Nam & Tatum, 1997).

As already shown in figure 5.2-d, the systems integrator (also process integrator) is at the interface between the innovation superstructure and the innovation infrastructure. The systems integrator is like a proactive intermediary or catalyst, linking and aggregating the technological systems produced by element/component suppliers into solutions within the regulatory framework and built environment where the client uses it. The systems integrator main competences are:

- The skills to integrate interdependent components into a coherent whole
- Detailed knowledge of client requirements
- Knowledge of the rules and regulations governing the industry
6.3 Future positioning options for consulting engineers

In paragraph 2.5, the position of DHV was characterised according to the level of process integration and the level of innovative entrepreneurship. As figure 6.3-a indicates there are several positioning options for consulting engineers. The characterization of the current situation in construction as described in the first phase of this research, showed that consulting engineers might be very traditional and specialized while others are forward and/or backward integrating in the construction process. In a supply-driven construction industry there is more opportunity for consulting engineers to enact more into innovative entrepreneurship. A consultancy and engineering firm as developing innovator can be positioned in the quadrant ‘innovative’ while consulting engineers taking a partnering or leading role in a supplying consortium or as a systems integrator can be positioned in the quadrant ‘modern’.

In addition, figure 6.3-b presents another schematization four different positioning options for consulting engineers based on two axes. On the horizontal axis consulting engineers can either be responsive (capacity deliverer) or proactive (developing and integrating systems). On the vertical axis, they can be involved at the supply side (client side) or demand side (contractor side). The schematization as shown in figure 6.3-b will be used in following analyses in chapter 7 and 8. First, some expectations are described regarding these four positions.

Figure 6.3-a: Positioning options for consulting engineers.

Figure 6.3-b: Possible positions for consulting engineers at the demand or supply side and in a responsive or proactive position.
Position 1:
The first quadrant represents the traditional position of a consultancy and engineering firm. Here consulting engineers are hired by clients on hours-fees basis and traditionally provide specialist advisory like planning, design, engineering or project management activities. The consulting engineer has a responsive position regarding client demand. As more design and engineering tasks are shifted towards contractors in the supply-driven construction industry, procurement advisory will become one of the most important activities at client side for consulting engineers. Clients’ specialist (procurement) consulting engineer is able to match the client’s wishes and requirements with the suppliers’ total (integrated) solutions.

Important skills and knowledge of consulting engineers in this position are contracting, tender procedures, risk management and (functional) demand specifications. Employees are expected to understand the demand of the client and therefore consulting engineers in this role must be client oriented and a mix of specialist and generalist. The organisation is expected to be project-based, responding to market needs (outside-in) and delivering value added by consultancy and engineering capacity wherever needed. Therefore the competitive advantage in this position will be a combination of capacity and knowledge and expertise. As clients’ specialist (procurement) consulting engineer, they will have to bear higher risks for effectively selecting and managing the solution to the client’s problem.

Position 2:
The second quadrant represents the position where the client does not hire the consulting engineer, but instead the contractor (supply side). Consulting engineers deliver specialist capacity to the contractor and have a subcontracting responsive role in the supplying chain. Consulting engineers in this position are recognized by skills and knowledge in engineering and designing. Having a subcontracting role at the contractors’ side, the focus and culture of contractors will probably have its impact on the type of employees needed at consultancy and engineering firms. As contractors are efficiency oriented with a focus on the technical content of projects, consulting engineers also need to be technical and contractor oriented with a focus on efficiency. The organization is characterised by responsively delivering efficient capacity in projects (project-based). Again knowledge, expertise and capacity are the most important competitive advantages.

Position 3:
The third quadrant represents the position where the consulting engineer assists the client to find the best solution for the client’s problem. This intermediary consulting engineer is able to link societal issues, needs and problems proactively with the solutions and technologies delivered by the supplying chains (contractors). The intermediary has a central position in society connecting the (public) clients, professional institutions (universities) and the supplying industry, and therefore able to synchronize ‘the desirable’ and ‘the possible’ within the environment and regulatory frameworks where it is used. Having a central position as intermediary, this position requires skills and knowledge in networking. Networking is also the most important competitive advantage. Furthermore managing multidisciplinary problems, proactively seizing opportunities are characteristics of this type of consulting engineers.

Position 4:
The fourth quadrant represents a position where the consulting engineer has a proactive position at the supply side (contractors). The consulting engineer has a leading or partnering role in developing and offering totally integrated solutions (concepts/products). Strategic partnering between consulting engineers, contractors, component suppliers, element suppliers etc. enables to develop concepts/products (families) that can be repetitively implemented on several projects.

This position requires dealing with risks of innovations and market research. Starting point of this position are the internal capabilities (concepts/products) of the consultancy and engineering firm or consortium. This position requires entrepreneurship, proactiveness and a business orientation.

17 In Dutch: Maatschappelijke vraagstukken.
7. DHV-management questionnaire survey

A questionnaire survey is chosen as an appropriate research approach in order to achieve a statistical valid sample and perform a quantitative analysis to enhance the qualitative analysis. Starting point of this survey is the possible positioning of DHV in a future supply-driven construction industry. Chapter 6 finished with the identification of four possible future positions for consulting engineers, based on theories as described in chapter 5.

The aim of the questionnaire survey in this chapter is to investigate the opinions and attitudes of managers/executives at DHV within the Netherlands regarding those four possible positions. Therefore, chapter 6 is used as input for this questionnaire. The questionnaire itself has an empirical character since it covers opinions and attitudes from industry practitioners. The outcomes of the questionnaire are used for the discussion about future strategies as described in chapter 8.

7.1 Questionnaire and sample design

The questionnaire was designed to include multiple purposes. First, it included a short introduction to the model of a supply-driven construction industry, contrasting the current demand-driven construction industry. Then the four possible positions of consultancy and engineering firms in a future supply-driven industry covered four sections in the questionnaire. Each position/section started with a small description of this position/role within the industry. In order to perform a sound and structured analysis on the four positions, each section covered the same questions. The questions in each section focused on (1) general capabilities required for that specific position, (2) the situation of DHV for that specific position and (3) the preferences and expectations of DHV-management regarding that specific position (see figure 7.1).

![Figure 7.1: Questionnaire design DHV-management survey](image-url)
The questionnaire was conducted with the aid of a web-based application named ‘NetQuestionnaire’. Respondents were approached by email explaining the goal of the survey and topics covering the survey. A web-link was accompanied in this email where respondent were invited to click upon to enter the questionnaire. Advantages to choose for this method are that this approach is very efficient and reliable. Conducting a questionnaire by hardcopy would cause a lot of paperwork, risk of entry errors and risk of unreadable handwriting. In order to keep up the respondents’ attention, a mix of different types of questions was used. Some opinions questions were asked on a ‘Likert’ scale indicating the level of agreement ranging from (1) highly disagree to (5) highly agree.

Other questions in the questionnaire were combination questions where a part of the answers were ‘closed’ and part of the answer was ‘open’. Closed answers were based on the literature research and interviews conducted in chapters 1 to 6 in this research. With the open answer option ‘Other, namely’ respondents were able to complement their answers according to their own opinion. The questionnaire survey and approach-email are added in appendix C.

Appendix C also shows that besides an initial approach-email in English, also a second approach strategy was used. The second email strategy was used to catch more respondents’ attention by distributing a shorter email in Dutch and more challenging. In ‘NetQuestionnaire’ the layout and structure of the survey can be programmed according to the purposes of the specific survey. A screenshot as an example of the layout used in the DHV-management questionnaire is presented in appendix C.

The questionnaire was sent to 130 managers/executives representing business units or departments with a size of approximately 15 employees or larger. Besides managers/executives at the head-office of DHV in Amersfoort, also managers/executives from the regional offices like in the Hague, Eindhoven, Rotterdam, Groningen or Zaandam were invited to participate in the survey. The questionnaire was online accessible over a period of two weeks between June 4th 2007 and June 18th 2007.

After one week, the response was somewhat disappointing so after that the second approach strategy was used as a reminder. Since the ‘Environment and Transportation’ business group is the largest business group and the business group that is most involved in civil engineering works, more emphasis was put on getting more response from this business group. A large share of this business group has been called by phone in order to remind and invite them to participate in the management survey.

Furthermore it is interesting to note that out of the 130 managers/executives who were approached, 76 (58%) actually started the survey by clicking on the link to see what kind of questions were asked. At the point of question A1 (the first relevant question) a large share of the 76 respondents quit.

<table>
<thead>
<tr>
<th>Business group</th>
<th>Number of respondents approached</th>
<th>Number of responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Environment &amp; Transportation</td>
<td>75</td>
<td>21</td>
</tr>
<tr>
<td>Buildings &amp; Industry</td>
<td>35</td>
<td>5</td>
</tr>
<tr>
<td>Water</td>
<td>10</td>
<td>1</td>
</tr>
<tr>
<td>Aviation</td>
<td>6</td>
<td>0</td>
</tr>
<tr>
<td>Holding</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>130</td>
<td>27 (21%)</td>
</tr>
</tbody>
</table>

Table 7.1: Response statistics of the DHV-management survey.

In total, out of the 130 respondents 27 managers have fully finished the questionnaire. This results in a response rate of 21%. Looking at the 76 respondents who were at least interested to see the questionnaire, a response of 27 would result in a response rate of 36%. An overview of the response per business group is presented in table 7.1.
A sample size of 27 (n = 27) is acceptable since this sample is primarily used for univariate data analysis. The sample size also conforms to the rule of thumb that the sample size must at least be larger than 25 cases (Baarda and De Goede, 2001). In general, a larger sample size is needed if:

- Heterogeneity of answers is higher.
- More sub-group analyses are wanted.
- Higher accuracy needed.

As this sample is not used to explore or confirm any correlations or differences between sub-groups like differences between males and females or differences between business groups, the sample size is acceptable for the primary objective of this survey.

Before doing an in depth analysis on the results, first some general descriptives are discussed. The average age of the respondents was 47.4 years, with a minimum of 35 and a maximum of 61 years. Out of the 27 respondents who fully completed the questionnaire, 23 (85%) are male and 4 (15%) are female. Looking at the different business groups, with 21 respondents (78%), ‘Environment and Transportation’ is overrepresented compared to the other business groups. As mentioned, more emphasis was put on this business group so these results are not unexpected. Therefore, this sample does not allow to do sub-group analysis between different business groups.

The background educations of the respondents are dominated by ‘engineering and technology’ with 18 respondents (67%). 3 respondents (11%) have ‘social sciences’ as background education and 1 respondent (4%) has ‘business administration’ as background education. Moreover, 5 respondents (19%) indicated to have a combination of these educations as background education. A detailed overview of these descriptives per category is presented in appendix D.
7.2 Required capabilities of future positioning options

This part of the questionnaire aims to reveal what general capabilities are needed at DHV for every position as defined. These requirements include skills and knowledge, type of employees, type of organization, competitive advantage and the level of risk-taking participation in projects. Per category a list of items was provided where the respondents were asked to check the items where appropriate in their opinion (see appendix C for the full questionnaire). The positions as defined for DHV are presented in figures 6.3-b and 7.1.

Respondents were allowed to select three to five items from the list (or define items themselves) and consequently an overall ranking of the most important items per category is constructed by adding up all the scores of the respondents. Tables 7.2-a through 7.2-d provide an overview of the most important items per category. Note that only the items that are indicated by more than 40% of the respondents are included in these tables.

Skills and knowledge:

<table>
<thead>
<tr>
<th>P1: Clients’ specialist consultant</th>
<th>%</th>
<th>P3: Clients’ intermediary</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Project management</td>
<td>58%</td>
<td>1) Multidisciplinary problems</td>
<td>56%</td>
</tr>
<tr>
<td>2) Contracting</td>
<td>54%</td>
<td>2) Networking</td>
<td>44%</td>
</tr>
<tr>
<td>3) Risk management</td>
<td>50%</td>
<td>3) Strategic partnering</td>
<td>41%</td>
</tr>
<tr>
<td>4) Tender procedures</td>
<td>46%</td>
<td>3) Risk management</td>
<td>41%</td>
</tr>
<tr>
<td>4) Regulatory frameworks</td>
<td>46%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>P2: Contractors’ specialist consultant</th>
<th>%</th>
<th>P4: Integrated product developer, partner</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Engineering</td>
<td>74%</td>
<td>1) Risk management</td>
<td>52%</td>
</tr>
<tr>
<td>2) Designing</td>
<td>59%</td>
<td>2) Multidisciplinary problems</td>
<td>48%</td>
</tr>
<tr>
<td>3) Risk management</td>
<td>41%</td>
<td>3) Strategic partnering</td>
<td>44%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4) Entrepreneurship</td>
<td>41%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>P1: Clients’ specialist consultant</th>
<th>%</th>
<th>P3: Clients’ intermediary</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Client oriented</td>
<td>73%</td>
<td>1) Client oriented</td>
<td>78%</td>
</tr>
<tr>
<td>2) Mix of specialist and generalist</td>
<td>58%</td>
<td>2) Proactive</td>
<td>48%</td>
</tr>
<tr>
<td>3) Proactive</td>
<td>42%</td>
<td>3) Mix of specialist and generalist</td>
<td>48%</td>
</tr>
<tr>
<td>3) Opportunity oriented</td>
<td>44%</td>
<td>3) Opportunity oriented</td>
<td>44%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>P2: Contractors’ specialist consultant</th>
<th>%</th>
<th>P4: Integrated product developer, partner</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Technical oriented</td>
<td>67%</td>
<td>1) Entrepreneurial</td>
<td>63%</td>
</tr>
<tr>
<td>2) Specialist</td>
<td>48%</td>
<td>2) Business oriented</td>
<td>56%</td>
</tr>
<tr>
<td>3) Contractor oriented</td>
<td>44%</td>
<td>2) Mix of specialist and generalist</td>
<td>56%</td>
</tr>
<tr>
<td>3) Efficiency oriented</td>
<td>44%</td>
<td>3) Proactive</td>
<td>48%</td>
</tr>
<tr>
<td>3) Proactive</td>
<td>44%</td>
<td>4) Opportunity oriented</td>
<td>41%</td>
</tr>
<tr>
<td>4) Innovative</td>
<td>41%</td>
<td>4) Innovative</td>
<td>41%</td>
</tr>
</tbody>
</table>

Table 7.2-a: Required skills and knowledge for the future positions.
* All items that are stated by more than 40% of the respondents are included in the table.

Looking at the most important skills and knowledge in the questionnaire, all items per category seem to fit in that position for DHV. It is remarkable that for all four positions ‘risk management’ is stated as an important skill/knowledge.

Type of employees:

<table>
<thead>
<tr>
<th>P1: Clients’ specialist consultant</th>
<th>%</th>
<th>P3: Clients’ intermediary</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Client oriented</td>
<td>73%</td>
<td>1) Client oriented</td>
<td>78%</td>
</tr>
<tr>
<td>2) Mix of specialist and generalist</td>
<td>58%</td>
<td>2) Proactive</td>
<td>48%</td>
</tr>
<tr>
<td>3) Proactive</td>
<td>42%</td>
<td>3) Mix of specialist and generalist</td>
<td>48%</td>
</tr>
<tr>
<td>3) Opportunity oriented</td>
<td>44%</td>
<td>3) Opportunity oriented</td>
<td>44%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>P2: Contractors’ specialist consultant</th>
<th>%</th>
<th>P4: Integrated product developer, partner</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Technical oriented</td>
<td>67%</td>
<td>1) Entrepreneurial</td>
<td>63%</td>
</tr>
<tr>
<td>2) Specialist</td>
<td>48%</td>
<td>2) Business oriented</td>
<td>56%</td>
</tr>
<tr>
<td>3) Contractor oriented</td>
<td>44%</td>
<td>2) Mix of specialist and generalist</td>
<td>56%</td>
</tr>
<tr>
<td>3) Efficiency oriented</td>
<td>44%</td>
<td>3) Proactive</td>
<td>48%</td>
</tr>
<tr>
<td>3) Proactive</td>
<td>44%</td>
<td>4) Opportunity oriented</td>
<td>41%</td>
</tr>
<tr>
<td>4) Innovative</td>
<td>41%</td>
<td>4) Innovative</td>
<td>41%</td>
</tr>
</tbody>
</table>

Table 7.2-b: Required type of employees for the future positions.
* All items that are stated by more than 40% of the respondents are included in the table.

The most frequent mentioned items regarding the type of employees again seem to fit for all categories. Somewhat unexpected is that respondents indicate that also positions 1 and 2 require proactive employees.
A supply-driven construction industry for transportation infrastructure

Type of organization:

<table>
<thead>
<tr>
<th>P1: Clients’ specialist consultant</th>
<th>P3: Clients’ intermediary</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Responding to market needs (outside-in)</td>
<td>1) Proactively exploiting its capabilities (inside-out)</td>
</tr>
<tr>
<td>2) Shaped by projects (project-based)</td>
<td>1) Delivering value added by integrating client demand and market supply (technologies) proactively</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>P2: Contractors’ specialist consultant</th>
<th>P4: Integrated product developer, partner</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Shaped by projects (project-based)</td>
<td>1) Proactively exploiting its capabilities (inside-out)</td>
</tr>
<tr>
<td>2) Delivering value added by consultancy and engineering capacity, wherever needed</td>
<td>2) Delivering value added by innovative solutions</td>
</tr>
<tr>
<td>3) Responding to market needs (outside-in)</td>
<td>3) Delivering value added by integrating client demand and market supply (technologies) proactively</td>
</tr>
</tbody>
</table>

Table 7.2-c: Required type of organization for the future positions.
* All items that are stated by more than 40% of the respondents are included in the table.

Looking at the type of organization, there is a clear difference between positions 1 and 2, and 3 and 4. Positions 1 and 2 require an organization that is shaped by projects (project-based) and responding to market needs (outside-in). On the contrary, positions 3 and 4 require an organization that is proactively exploiting its capabilities (inside-out).

Type of competitive advantage:

<table>
<thead>
<tr>
<th>P1: Clients’ specialist consultant</th>
<th>P3: Clients’ intermediary</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Knowledge and expertise</td>
<td>1) Networking</td>
</tr>
<tr>
<td>2) Capacity</td>
<td>2) Knowledge and expertise</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>P2: Contractors’ specialist consultant</th>
<th>P4: Integrated product developer, partner</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Knowledge and expertise</td>
<td>1) Knowledge and expertise</td>
</tr>
<tr>
<td>2) Capacity</td>
<td>2) Innovation (R&amp;D, learning)</td>
</tr>
<tr>
<td>3) Innovation (R&amp;D, learning)</td>
<td>3) Networking</td>
</tr>
</tbody>
</table>

Table 7.2-d: Required type of competitive advantage for the future positions.
* All items that are stated by more than 40% of the respondents are included in the table.

As competitive advantage, respondents mentioned knowledge and expertise in all four categories. Knowledge and expertise seems to be a kind of baseline competitive advantage or ‘raison d’être’. In addition positions 1 and 2 have ‘capacity’ as competitive advantage, position 3 ‘networking’ and position 4 ‘networking’ and ‘innovation’.

The last category in this part of the questionnaire is the level of risk-taking participation in projects. This question is measured on a ‘Likert’ scale ranging from 1) ‘strongly disagree’ to 5) ‘strongly agree’.

The mean values per position indicate whether there is on average more disagreement or agreement. The expected mean of a scale ranging from 1 to 5 equals \((1+2+3+4+5)/5 = 3\). Therefore, a mean higher than 3 indicates an average opinion towards agreement and a mean lower than 3 indicates an average opinion towards disagreement. Looking at the mean values for the question “Looking at this position for DHV, I would aim to participate more into risk-taking projects”, all values are larger than 3. The highest mean was assigned to position 4, namely 3.8.

Figure 7.2-a presents the aggregated percentages over the five categories of answers per positioning option for DHV. A negative skew is observed indicating the asymmetry of the distribution of answers in this sample. The left tail is the longest; the mass of the answers in this sample is concentrated on the right of the figure. Thus, this analysis shows that respondents would aim for more risk-taking participation in all 4 positions and especially in position 4.
Looking at this position for DHV, I would aim to participate more into risk-taking projects

![Bar chart](image)

Figure 7.2-a: Bar chart of the percentages of agreement regarding the level of risk-taking participation per answer category.

The standard deviation is the most common measure of statistical dispersion, measuring how widely spread the values in a sample are. If the answers are close to the mean, then the standard deviation is small. As well, if many answers are far from the mean, then the standard deviation is large. As table D-5 shows, the highest standard deviation is 1.2 for position 1 and the lowest standard deviation is 0.7 for position 4. The heterogeneity of answers is larger for position 1 than for position 4. In other words, there is more unanimity about risk-taking participation in position 4 than in position 1.

![Bar chart](image)

Figure 7.2-b: Bar chart of the percentages of agreement regarding the level of risk-taking participation per position.

Figure 7.2-b provides an alternative representation of the data where the scores can be compared more easily between the four positions. Position 4 shows on average the highest agreement on the level of risk-taking participation in projects. It is also interesting to see that more than 60% of the managers would aim for more risk-taking participation at the contractors’ side in a responsive role (position 2).
7.3 The situation of DHV (SWOT analysis)

The second part of the questionnaire investigated the strengths, weaknesses, opportunities and threats per future positioning option according to DHV-management. Besides two or three suggestions that were already provided per positioning option, respondents were also allowed to state their own suggestions. The problem of this method might be that a part of the respondents might not have used the opportunity to state their own suggestions regarding these SWOT aspects. Therefore, besides statistical analysis of the predetermined answers in these questions, also careful consideration must be given to the open inputs of respondents.

Table 7.3 presents the results of the SWOT analyses of all positions as defined. In appendix E also the items with a lower percentage than 40% and ‘open’ answers are included in the table.

For DHV it is important to have more insight into its internal strength and weaknesses, and external opportunities and threats in order to aim for the most competitive and profitable position and role (strategy). For strategic planning, often a SWOT-analysis (strength, weaknesses, opportunities and threats) is performed. The SWOT analysis combines two important schools in strategic planning. The first is the ‘outside in’ school which studies its external environment (competitors, markets, change-drivers and forces affecting industry competitive intensity) prior to developing specific product-market strategies. The second is the ‘inside out’ school, which advocates that strategies flow outwards from a firm’s capabilities.

![Figure 7.3: SWOT-analysis framework, Grant (2002).](image)

The framework used for this analysis is depicted in figure 7.3. It must be noted that the classification into strengths or weaknesses, and opportunities or threats is more or less arbitrary. Therefore more important is the distinction between internal factors and external factors and the appraisal of their implications. The SWOT-analysis is conducted from the perspective that the market will change from a demand-driven pull market to a supply-driven push market.

The SWOT analysis shown in table 7.3 together with the full SWOT analyses shown in appendix E, are used for the discussion and strategies of chapter 8.
<table>
<thead>
<tr>
<th>P1: Clients’ specialist consultant</th>
<th>P3: Clients’ intermediary</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Strengths:</strong></td>
<td></td>
</tr>
<tr>
<td>1) Very experienced in project management and procurement management</td>
<td>1) Good relationships with all relevant actors</td>
</tr>
<tr>
<td>2) Broad knowledge in all phases of the project life-cycle (integrated)</td>
<td>2) Broad knowledge at DHV in terms of many disciplines in all project phases</td>
</tr>
<tr>
<td><strong>Weaknesses:</strong></td>
<td></td>
</tr>
<tr>
<td>1) No sufficient portfolio management</td>
<td>1) Employees are not geared towards proactive integration of supply and demand</td>
</tr>
<tr>
<td><strong>Opportunities:</strong></td>
<td></td>
</tr>
<tr>
<td>1) Procurement advisory becomes increasingly important as clients return to their core business</td>
<td>1) Potential clients recognize the unique position and value added of DHV and are willing to pay higher rates for these services</td>
</tr>
<tr>
<td>2) Early project involvement becomes a competitive advantage</td>
<td>2) This proactive position attracts new employees</td>
</tr>
<tr>
<td><strong>Threats:</strong></td>
<td></td>
</tr>
<tr>
<td>1) Dependency on some major (public) clients like Rijkswaterstaat</td>
<td>1) This position/role is not recognized by potential clients</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>P2: Contractors’ specialist consultant</th>
<th>P4: Integrated product developer, partner</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Strengths:</strong></td>
<td></td>
</tr>
<tr>
<td>1) Broad knowledge in all phases of the project life-cycle (integrated)</td>
<td>1) DHV has experience from both a client perspective as well as from a contractor perspective. This might enable DHV to take a participative or even a leading role within a consortium or supply chain</td>
</tr>
<tr>
<td>2) Low cost engineering in India</td>
<td>2) Broad knowledge and expertise is available to develop new concepts/products</td>
</tr>
<tr>
<td><strong>Weaknesses:</strong></td>
<td></td>
</tr>
<tr>
<td>1) Culture mismatch between DHV and contractors</td>
<td>1) Investments very risky due to ‘short’ balance sheet</td>
</tr>
<tr>
<td>2) Employees are not geared towards proactive concept/product development</td>
<td>2) Employees are not geared towards proactive concept/product development</td>
</tr>
<tr>
<td>3) Unfamiliar with marketing and branding of products/concepts</td>
<td>3) Unfamiliar with marketing and branding of products/concepts</td>
</tr>
<tr>
<td><strong>Opportunities:</strong></td>
<td></td>
</tr>
<tr>
<td>1) Market share of design and engineering at contractors’ side is growing due to integrated contracts</td>
<td>1) Clients increasingly demand totally integrated solutions and one focal point for their product/service delivery</td>
</tr>
<tr>
<td>2) Contractors are increasingly dependent on specialist (engineering) consulting engineers</td>
<td>2) Market shift from a lowest price system to a quality system, so innovation is rewarded</td>
</tr>
<tr>
<td><strong>Threats:</strong></td>
<td></td>
</tr>
<tr>
<td>1) Subcontracting role and thus risk of being squeezed out by the contractor</td>
<td>1) Other rivals (vertical and horizontal competition)</td>
</tr>
<tr>
<td>2) Contractors acquire in-house specialist consulting engineers and therefore less dependent on external consulting engineers</td>
<td>2) There is no (or overestimated) demand for DHV’s concepts/products</td>
</tr>
</tbody>
</table>

Table 7.3: SWOT analyses of DHV for all positions. *All ‘open’ answers and items that are stated by more than 40% of the respondents are included in the table.*
7.4 Preferences and expectations of DHV-management

The third and last part in the questionnaire put emphasis on the expectations and preferences of DHV managers. The desirability, expected profitability and expected organizational change of the four positions were investigated. Although choosing for one of the four positions might not be necessary at all, DHV managers were asked to choose one of the four positions.

**Expected organizational change**

Figure 7.1 shows an arrow between ‘general required capabilities’ and ‘situation of DHV’ accompanied by the text “Gap?”. Comparing the general capabilities required per future position, with the situation of DHV per position in terms of strength and weaknesses, a gap may be revealed in terms of organizational changes needed. In the questionnaire, respondents are asked to indicate to what extent they think organizational changes are needed looking at the possible gap between DHV’s current position and the future possible positions. Respondents are asked to what level they agree with the proposition “I think this position will require little organizational changes for DHV”. A higher score on a scale from 1 to 5 means little organizational changes are expected.

Table D-6 in appendix D shows the mean values and standard deviations. For positions 1 through 3 the average value is slightly positive, namely 3.1. The mean value of position 4 is lower and negative with a value of 2.7. This means that on average respondents think that position 4 does not require little organizational changes for DHV. In other words, according to DHV-management, position 4 has the largest gap compared to the current situation of DHV. Furthermore, position 4 also reveals the largest standard deviation indicating a low level of unanimity among the managers.

![Bar chart showing agreement on organizational changes](image)

**Figure 7.4-a: Bar chart of the percentages of agreement regarding the expected organizational change needed for all positions.**

Figure 7.4-a shows that the largest shares of answers can be found at ‘disagree’ and ‘agree’. This indicates that the managers of DHV in this sample do not share the same vision regarding the level of organizational change needed for those four positions. Another explanation might be that different groups of respondents are involved in different business activities at DHV and therefore have different perspectives.

Positions 1 through 3 more or less look the same, while position 4 looks quite different. On average, DHV managers think position 4 requires more organizational change than the other three positions. Moreover, this figure also shows that a substantial group expects that little organizational change is needed for position 4.
Expected profitability

Looking at the profitability of the positions, table D-7 in appendix D, shows that on average position 3 (clients’ intermediary) is expected to be most profitable for DHV. The position that is expected to be least profitable is position 2 (contractors’ specialist (engineering) consulting engineer). The highest standard deviation is 1.0 for position 2 and the lowest standard deviation is 0.8 for position 4.

Desirability of positions

Figure 7.4-b: Bar chart of the percentages of agreement regarding the expected profitability for all positions.

Figure 7.4-b shows a bar chart of the percentages of agreement on the expected profitability of the four positions. It is noticed that a relative large share of the respondents choose for the third category ‘neither agree nor disagree’. This may be caused by the fact that not everyone holds a strong view on the future profitability of the positions or maybe they simply cannot make a proper guess. On average, the expected profitability is higher for positions 3 and 4 than for positions 1 and 2.

Figure 7.4-c shows that the majority of answers are found at category 4 ‘desired’. On the other hand, it is remarkable that a significant part of the respondents (33%) indicated that position 2 is undesired.

Desirability of possible positions in a supply-driven industry
A supply-driven construction industry for transportation infrastructure

### Desirability of possible positions in a supply-driven industry

<table>
<thead>
<tr>
<th>Position</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>P1: Clients’ specialist consultant (mean = 3.8)</td>
<td>30%</td>
</tr>
<tr>
<td>P2: Contractors’ specialist consultant (mean = 3.1)</td>
<td>70%</td>
</tr>
<tr>
<td>P3: Clients’ intermediary (mean = 4.0)</td>
<td>60%</td>
</tr>
<tr>
<td>P4: Integrated product developer, partner (mean = 3.5)</td>
<td>10%</td>
</tr>
</tbody>
</table>

**Figure 7.4-d: Bar chart of the percentages of agreement regarding the desirability for all positions.**

Looking at the desirability of the four positions, figure 7.4-d, shows that the highest average desirability of 4.0 is shown at position 3. The lowest average desirability of 3.1 is shown at position 2. On average all four positions score higher than 3.0 indicating that none of the positions is clearly undesired. A remarkable outcome is that 30% of the respondents indicate that position 3 is highly desired. Opinions on position 2 are split between two substantial groups, one indicating ‘undesired’ and the other indicating ‘desired’. Compared to the other three positions, position 4 has a relative large share of respondents indicating ‘neither (un)desired’.

### Average desirability per position for DHV

- P1: Clients’ specialist consultant (procurement) consultant
- P2: Contractors’ specialist consultant (engineering) consultant
- P3: Clients’ intermediary
- P4: Integrated concept/product developer or partner

**Figure 7.4-e: Bar chart of the average desirability per position for DHV on a scale from 1 to 5.**

The average desirability of the four positions as stated in figure 7.4-d, is also shown in figure 7.4-e. Interesting result from this figure is that position 1 is also very desired by DHV managers. The two most desired positions are position 1 and 3, which are both at the client side. On average, managers in this sample indicate a future positioning at the client side as more desirable compared to the contractor side.

On the other hand, as figure 7.4-h shows, if DHV managers would have to choose for one of the four positions in the future supply-driven industry, 52% chooses for position 3 being clearly the most preferred position for DHV.
Remarkably, on average position 1 was the second most desirable position for DHV. Now looking at figure 7.4-f, position 4 is second most preferred position with 30% versus only 11% choosing for position 1. Although position 1 can be considered desirable, managers choose for positions 3 and 4 as most preferred future positions.

The most important reasons to choose for a specific position are shown in table D-12 in appendix D. 81% of the respondents chose for that position because of the competitive position of DHV. Another important reason with 63% was the profitability of DHV.
7.5 Summary

To conclude, this chapter describes the future required capabilities, a SWOT analysis, the expected organizational change, the expected profitability and the preferences of DHV managers with respect to the four future positioning options.

Most remarkable results are as follows:

- The most organizational change is expected for position 4: integrated concept/product developer, partner in consortia.
- A position at the clients’ side is more desired than at the contractors’ side.
- The most profitable position is expected to be position 3: clients’ intermediary.
- The most preferred position is position 3: clients’ intermediary.

An overview of the required future capabilities and SWOT analysis for the four positions is presented in tables 7.5-a through 7.5-d. The results of this chapter are further used for the discussion about future strategies in chapter 8.

**Overview of position 1: Clients’ specialist (procurement) consultant**

<table>
<thead>
<tr>
<th>Capabilities</th>
<th>Requirements</th>
<th>Strengths</th>
<th>Weaknesses</th>
</tr>
</thead>
</table>
| **Skills and knowledge** | 1) Project management 2) Contracting 3) Risk management 4) Tender procedures 4) Regulatory frameworks | - Very experienced in project and procurement management  
- Integrated knowledge in all phases project life-cycle  
- Good mix between process, content and context | - Insufficient portfolio management (alignment)  
- Dependency on clients as capacity deliverer (insufficient capacity or too high rates) |
| **Employees** | 1) Client oriented 2) Mix of specialist and generalist 3) Proactive | Opportunities                                                                 | Threats                                                                                          |
| **Organization** | 1) Responding to market needs (outside-in) 2) Shaped by projects | - Procurement advisory becomes increasingly important as client return to their core business  
-Early project involvement becomes a competitive advantage | - Dependency on some major (public) clients like Rijkswaterstaat (frame agreements)  
-Shrinking market share at client side |
| **Competitive advantage** | 1) Knowledge and expertise 2) Capacity |                                                                 |                                                                                                  |

*Table 7.5-a: Overview of position 1: clients’ specialist (procurement) consultant.*
### Overview of position 2: Contractors’ specialist (engineering) consultant

<table>
<thead>
<tr>
<th>Capabilities</th>
<th>Requirements</th>
<th>Strengths</th>
<th>Weaknesses</th>
</tr>
</thead>
</table>
| **Skills and knowledge** | 1) Engineering  
2) Designing  
3) Risk management | - Integrated knowledge in all phases project life-cycle | - Culture mismatch between DHV and contractors |
| **Employees** | 1) Technical oriented  
2) Specialist  
3) Contractor oriented  
4) Efficiency oriented  
5) Proactive  
6) Innovative | - Low cost engineering in India  
- Broad knowledge base to deliver value added to contractors | - Project and quality control might be hampered in this subcontracting responsive role  
- DHV is not efficiency oriented |
| **Organization** | 1) Shaped by projects  
2) Delivering value added by consultancy and engineering capacity, wherever needed  
3) Responding to market needs (outside-in) | - Market share of design and engineering at contractors’ side is growing due to integrated contracts  
- Contractors are increasingly dependent on specialist (engineering) consulting engineers | - Subcontracting role and thus risk of being squeezed out by the contractor  
- Contractors acquire in-house specialist consulting engineers and will be less dependent on external consulting engineers |

**Opportunities**

**Threats**

<table>
<thead>
<tr>
<th>Capabilities</th>
<th>Requirements</th>
<th>Strengths</th>
<th>Weaknesses</th>
</tr>
</thead>
</table>
| **Skills and knowledge** | 1) Multidisciplinary problems  
2) Networking  
3) Strategic partnering  
3) Risk management | - Good relationships with all relevant actors  
- Multidisciplinary expertise | - Employees are not geared towards proactive integration of supply and demand |
| **Employees** | 1) Client oriented  
2) Proactive  
2) Mix of specialist and generalist  
3) Opportunity oriented | | |
| **Organization** | 1) Proactively exploiting its capabilities (inside-out)  
1) Delivering value added by integrating client demand and market supply (technologies) proactively  
2) Responding to market needs (outside-in) | - Potential clients recognize the unique position and value added of DHV and are willing to pay higher rates for these services  
- This proactive position attracts new employees | - Market is not ready for this position / not recognized or DHV cannot prove its value added compared to its competitors |

**Opportunities**

**Threats**

### Overview of position 3: Clients’ intermediary

<table>
<thead>
<tr>
<th>Capabilities</th>
<th>Requirements</th>
<th>Strengths</th>
<th>Weaknesses</th>
</tr>
</thead>
</table>
| **Skills and knowledge** | 1) Multidisciplinary problems  
2) Networking  
3) Strategic partnering  
3) Risk management | | |
| **Employees** | 1) Client oriented  
2) Proactive  
2) Mix of specialist and generalist  
3) Opportunity oriented | | |
| **Organization** | 1) Proactively exploiting its capabilities (inside-out)  
1) Delivering value added by integrating client demand and market supply (technologies) proactively  
2) Responding to market needs (outside-in) | - Potential clients recognize the unique position and value added of DHV and are willing to pay higher rates for these services  
- This proactive position attracts new employees | - Market is not ready for this position / not recognized or DHV cannot prove its value added compared to its competitors |

**Opportunities**

**Threats**

<table>
<thead>
<tr>
<th>Capabilities</th>
<th>Requirements</th>
<th>Strengths</th>
<th>Weaknesses</th>
</tr>
</thead>
</table>
| **Skills and knowledge** | 1) Networking  
2) Knowledge and expertise | | |
| **Employees** | | | |
| **Organization** | | | |

Table 7.5-b: Overview of position 2: contractors’ specialist (engineering) consultant.

Table 7.5-c: Overview of position 3: clients’ intermediary.
## Overview of position 4: Integrated concept/product developer, partner in consortia

<table>
<thead>
<tr>
<th>Capabilities</th>
<th>Requirements</th>
<th>Strengths</th>
<th>weaknesses</th>
</tr>
</thead>
</table>
| Skills and knowledge | 1) Risk management  
2) Multidisciplinary problems  
3) Strategic partnering  
4) Entrepreneurship | - Experience from both a client as well as a contractor perspective | - Result based investments very risky  
- Employees are not geared towards proactive concept/product development  
- Not entrepreneurial enough |
| Employees          | 1) Entrepreneurial  
2) Business oriented  
3) Mix of specialist and generalist  
4) Proactive  
4) Opportunity oriented  
4) Innovative | - A lot of knowledge and expertise available to develop concepts/products | Opportunities                                                                 |
| Organization       | 1) Proactively exploiting its capabilities (inside-out)  
2) Delivering added by innovative solutions  
3) Delivering value added by integrating client demand and market supply (technologies) proactively | - Clients increasingly demand totally integrated solutions and one focal point for their products/services | Threats                                                                 |
| Competitive advantage | 1) Knowledge and expertise  
2) Innovation (R&D, learning)  
3) Networking | - Market shift from a lowest price system to a quality (value-cost ratio) system, so innovation is rewarded | - Other rivals (vertical and horizontal competition)  
- There is no (or overestimated) demand for DHV’s concepts/products |

*Table 7.5-d: Overview of position 4: integrated concept/product developer, partner in consortia.*
8. Discussion about future strategies

This discussion focuses on the four possible future positions for consulting engineers in a supply-driven construction industry. Besides the theoretical (literature) and empirical (questionnaire survey) results, also an interview with managing director Vic Prins is used as input for this discussion. Appendix F provides the details of the interview with managing director Vic Prins.

Comparing the required future capabilities with the current strengths and weaknesses indicates the gap between the current and future situation. Furthermore, confronting the opportunities and threats with the strengths and weaknesses can be useful to derive possible strategies.

DHV in position 1
With respect to the experience, skills and knowledge of DHV in position 1, there seems to be a good fit with the requirements for this position. DHV is very experienced in project, risk and tender management at the client side. Although, DHV has broad and multidisciplinary knowledge and expertise, this position still involves mainly responsive capacity delivery for its clients (responding to market needs).

DHV is traditionally very strong in this position, but the market is changing. Clients tend to outsource larger and integral packages of consultancy services through frame agreements, which create a risky dependency on such important clients. On the other hand, early project involvement combined with the focus on the large-scale transportation infrastructure projects may reinforce DHV’s aim to be ‘up in the food chain’. The client side seems to remain the primary focus of DHV the coming years. However, the activities at the contractors’ side are growing as clients aim to return to their core business and more design-build contracts are used. It is expected that especially the civil engineering sector of transportation infrastructure remains to change very slow. DHV seems to have much potential to be more proactive, which might be a good strategy to be less dependent on clients and achieve a unique position.

DHV in position 2
With respect to the second position, DHV requires skills and knowledge in engineering, designing and risk management. Furthermore, it requires a strong focus on the technical content, efficiency and capacity, which resembles the culture at contractors. DHV is experienced in designing, engineering and risk management, but DHV is not typically efficiency oriented. In a subcontracting responsive role, DHV’s organizational culture does not match the culture at contractors.

This position shows good opportunities when the market share at the contractors’ side is growing due to design-build contracts. Contractors traditionally focused only on the realization stage in projects, but in this future situation contractors/consortia could decide to design, engineer and develop totally integrated solutions. Contractors lack specialist expertise in the planning stage of projects, so consulting engineers might fill this gap.

Major threat of this position is the subordinate role for consultancy and engineering companies. Consultancy and engineering companies will face the risk of being squeezed out by the contractor as the contractor dictates the project authority and control due to its financial ‘muscle’. Current experiences at the contractor side already show problems as the contractor considers consulting engineers as a subcontractor. Therefore, the surprisingly high percentage of DHV managers indicating to aim for more risk-taking participation in this position could be very risky (figure 7.2-b). Although DHV managers indicate for more risk-taking participation, even in this second position, they also stated that position 2 is undesired.

A strategy to overcome a part of the mismatch between consulting engineers and contractors is the possibility of low cost engineering in India, which offers a great strength in terms of delivering capacity at low rates. Nevertheless, DHV must carefully consider if this position is where they want to be. The
interview with a managing director at DHV revealed that DHV wants to be considered a partner instead of a subcontractor when working at the contractor side.

**DHV in position 3**

Looking at the third position, DHV has good relationships with all relevant actors in the industry. Combined with its multidisciplinary knowledge, this position seems to have a good fit with the requirements such as networking and skills and knowledge of multidisciplinary problems. On the other hand, this proactive and central position in the industry and society requires quite a different attitude for DHV in terms of proactively exploiting its capabilities, seizing opportunities and proactive integration of supply and demand.

This position shows good opportunities as this central and integrating position might be recognized by potential clients. This unique position might enable DHV to charge higher rates for its consultancy and engineering capabilities/services. If DHV can prove its value added to potential clients, they might create a structural competitive advantage also attracting new employees. On the other hand, there is the risk of not being recognized by potential clients who might not be ready for this type of industry position. It might also be difficult to show and convince potential clients the specific strengths (value added) relatively to DHV’s competitors.

DHV is currently experienced as process manager or delegated client at the client side, but lacks commercial and business oriented experience and employees. Managing director Vic Prins considers it very important for DHV look further than the demand as stated by clients, and proactively look for societal/market issues. Therefore, for this position DHV must also have ‘think leaders’ and ‘trend watchers’ who can create an integrated vision on several (preferably aligned) problems and scan for opportunities. This proactive attitude would result in much more activities that are not directly client specific, but instead driven from inside out and based on market research. It is doubtful, also dependent on client, if investments in such proactive activities reward.

**DHV in position 4**

The fourth position has a lot of potential for DHV as integrated concept/product developer, partner in consortia. With its multidisciplinary market knowledge, creativity and expertise, DHV is able to develop interesting concepts/products. Currently, several interesting ideas and concepts are present at DHV, but according to several interviewees, the commercialization process still hampers. There are some serious deficiencies looking at the requirements for this position. For instance, DHV has too few employees who are business oriented, entrepreneurial and commercial. DHV is also relatively risk averse, which is partly caused by the financial situation (limited investment capital) of consultancy and engineering companies that does not really allow for large and risky investments.

This position shows good opportunities with respects to the clients’ aim to demand totally integrated solutions and one focal point (integrated supply) for their product/service delivery. In addition, the market shift from a lowest price system towards a quality (value –cost ratio) system will result in clients that reward innovations. An important threat of this position is that DHV is being confronted with other rivals both horizontally (other consultancy and engineering companies) as vertically (other concept/product developers, contractors or suppliers). Another risk is that the demand for DHV’s solutions/concepts is overestimated and thereby not returning the investment.

As mentioned at position 2, when working at the contractors' side, DHV wants to be considered a partner within a consortium. This equal relationship and not a subordinate role will also be beneficial for the end-product. Currently, there is a trend towards construction projects where a consortium of parties acts as one focal point. In this perspective, more intense relationships between contractors, suppliers and consultancy and engineering companies are expected. Also managing director Vic Prins expects in the future more repetition of concepts/products, longer term relationships and a more supply-driven industry. However, for civil works, this model is expected to be less comprehensive than for other sectors like industrial installations or buildings. For DHV it is vital to avoid a subordinate role as subcontractor and aim to be a full partner within a consortium or commercialize innovations internally.
Promising future positions

Looking at the current situation of DHV, DHV traditionally focuses on the (public) clients. Therefore, positions 1 and 3 seem to require the least change compared to DHV’s current situation. In other words, positions 1 and 3 show the strongest fit between the current capabilities of DHV and the required future capabilities. According to DHV managers in the questionnaire survey, position 4 requires the most organizational change.

With respect to the term ‘organizational change’, one manager could refer to the type of staff/employees while others could refer to the skills or the structure of the organization. Implicitly, managers possibly refer to the total organization including the shared values, strategy, structure, systems, style, staff and skills. Therefore, it is important for DHV to realize that for an effective organization it necessary to align and match all these organizational factors. As the alignment and connections between these organizational factors determine the type of business model, for DHV it might become necessary to have different business models for different positions.

Looking at the opportunities and threats of DHV in a future supply-driven construction industry, position 1 seems to be a familiar position in a changed environment where a lot of rivalry is expected. The subordinate role in position 2 does not seem to be a very prosperous future for DHV delivering work capacity to the contractors. Position 3 seems to be a role for DHV that can result in a competitive edge with respect to other consultancy and engineering firms. Position 4 has good prospects since more ideas, innovations, concepts and solutions are being developed at the market (supply) side and much less dictated by the clients.

This analysis, more or less confirms the expectations of the profitability of the future positioning options according to DHV management. The survey revealed that DHV managers expect position 3 and position 4 to be the most profitable positions for DHV in a supply-driven construction industry. If the DHV managers in the survey would have to choose, 52% choose for position 3 and another 30% for position 4. The survey also revealed that position 2 is least desired, expected to be least profitable and only 7% would actually choose for this position. Both positions 1 and 3 are very much desired by DHV managers, but if they would have to choose, they choose the third position over the first position.

The SWOT analysis as well as the preferences and expectations of DHV management point out that DHV should aim for a more proactive and central position in the industry and society. DHV is already recognized as a thorough and reliable actor in the industry. DHV must engage the potential of its multidisciplinary knowledge and expertise in order to tackle societal issues like climate change, mobility, living environment etc. This means DHV needs to rely more on its internal capabilities. As clients’ intermediary, DHV must be able to integrate the demand of the clients who feel a need to invest in solutions that can relieve their problems/issues.

DHV as leading integrator

For a position as clients’ intermediary, DHV must aim for a more proactive and central position in the industry and society. DHV is already recognized as a thorough and reliable actor in the industry. DHV must engage the potential of its multidisciplinary knowledge and expertise in order to tackle societal issues like climate change, mobility, living environment etc. This means DHV needs to rely more on its internal capabilities. As clients’ intermediary, DHV must be able to integrate the demand of the clients who feel a need to invest in solutions that can relieve their problems/issues.

Where DHV currently has a decentralized organization and inherently a broad and emergent strategy, DHV needs to focus more on deliberate strategies effectively linking multiple disciplines. In this position, DHV should aim for a strategic portfolio where they can take a leading role as ‘think leader’ linking content, process and context.

18 These 7 factors refer to the 7S framework by McKinsey (http://www.12manage.com/methods_7S_nl.html)
DHV as developing innovator

In order to take a leading or partnering position at the supply side in the industry, the current business model needs to be changed. There are different levels of involvement in the commercialization of innovation. The most risky business for DHV would be internal commercialization as total solution provider. This requires DHV to do investments in concept/product development. As the current balance sheet does not allow for large investments, DHV can search for more investment capital for instance through a quotation on the stock exchange. A more appropriate strategy might be to look for strategic partners for long-term collaboration. Managing director Vic Prins also confirms this strategic direction for the future.

If DHV takes a proactive role as partner in a consortium, it must complement and align its business functions with other partners in the consortium. As a consortium, it is important to have a production focus instead of a project focus. Problem solving and continuous improvement have to be formally incorporated in order to learn and improve the concepts/product along the product life cycle. Also the traditional link between customer-order and project must be replaced by market research and product development. When DHV engages in strategic partnering with suppliers (contractors), it will loose its status of transparent and independent consultant. Therefore, in the future a clear choice between partnering as developing innovator in a supply chain or being an independent clients’ consultant might become inevitable.
9. Conclusions and recommendations

This chapter discusses the findings and outcomes of this research and provides an answer to the main research question as stated in chapter one:

What are the drivers, consequences and opportunities of the transition to a supply-driven end-user oriented construction industry for consultancy and engineering companies? And what role, positioning and strategy are most fit for DHV in a future supply-driven construction industry?

9.1 Conclusions

Increasing complexity and dynamics in construction

The construction industry faces a situation and context with increasing complexity and dynamics. Several factors are contributing to the complexity and dynamics resulting in more uncertainty and hampered control, especially looking at large infrastructure projects. These factors include technological developments, technological interfaces, social interfaces, complex planning procedures, large-scale endeavors and the ambiguity on the distribution of risks and responsibilities. In addition, there is an increasing pressure on the construction industry to contribute efficiently and effectively to complex societal issues like mobility, sustainable developments and quality of life.

Recognition of the need to change

An important driver for change in the construction industry is the recognition of the need to change. This recognition is reinforced by the continuous budget and time overruns, limited efficiency, limited innovation, fraud and adversarial relationships in the construction industry. In the Netherlands, this recognition is expressed by renewal initiatives such as ‘Regieraad Bouw’ and ‘PSIBouw’, alike the program ‘rethinking construction’ (‘construction excellence’) in the UK.

Public clients return to the core business leaving a gap

In addition, (public) clients like the Dutch government agency for transport, public works and water management ‘Rijkswaterstaat’, aim to return to the core business and thereby increasingly transfer activities to the contractors’ side. Consultancy and engineering firms that are traditionally the ‘right hand’ of the client, now increasingly have the opportunity to work at the contractors’ side.

New procurement methods and integrated contracts

A consequence of the recognition of the need to change and the altered role of (public) clients is the development of new procurement methods to overcome the inherent weaknesses of the traditional procurement model design-bid-build. The traditional procurement model is characterized by a high level of customization, a separation between design and realization phases and a rather static construction process. New methods of procurement focus on integration of the processes: program, design, realization, operation and maintenance. This trend reinforces forward and backward integration of several actors involved. For instance, contractors who traditionally only focused on the construction process are now also involved in the design, engineering or maintenance processes.

In the traditional procurement model the construction object is fixed in terms of full specifications that are put out to tender and as a result there is little opportunity to make strategic trade-offs, innovate and perform activities differently than the competitors. Now that clients aim to exploit more of the knowledge and expertise at the market and contractors or consortia are involved in an earlier stage of the construction process, the involvement of contractors or consortia is more integrated with more opportunity to innovate and do proposals. However, currently the withdrawal of Rijkswaterstaat in the Netherlands, expressed by less client interference and specifications that are more functional, still hampers. Moreover, also contractors and consulting engineers are struggling with new forms of collaboration and changing business strategies.
Less client interference and more room for innovation in the market
The trends in a changing construction industry point out that the procurement model is changing from a demand-driven and fragmented process towards a supply-driven and integrated process. Integrated contracts put more authority, control and responsibilities at the market. Whereas in the demand-driven construction industry supply follows demand, in the supply-driven construction industry demand follows supply.

From a responsive pull market to a proactive push market
In the supply-driven construction industry, a responsive pull market with a high level of client interference is replaced by a proactive push market with less client interference. From a conceptual perspective, a supply-driven construction industry implies that concepts or designs are less client-specific and more pre-engineered. The model of the supply-driven construction industry can be represented by figure 9.1-a. This figure indicates that only a small share of pre-contractual tender work is needed in an early project phase. Suppliers already have virtually pre-engineered product families which can be made client-specific in accordance with specific wishes and requirements. Several variables could be altered in order to customize conceptually standardized products.

![Figure 9.1-a: The bottom-up supply-driven push market (De Ridder & Vrijhoef, 2007).](image)

New positions for consulting engineers
As figure 9.1-b shows, for consultancy and engineering firms like DHV there are several opportunities and different positioning options in a future supply-driven construction industry. Consulting engineers could choose for a responsive position delivering expertise wherever needed or for a proactive position as developer, innovator or intermediary (systems integrator). Furthermore, consulting engineers could choose to work either at the clients’ side or at the contractors’ side.

![Figure 9.1-b: Possible future positioning options for consulting engineers.](image)
High expectations for positions 3 and 4

The results of the DHV-management questionnaire survey in the third part of the research, show high expectations for position 3 and position 4. Besides skills and knowledge of multidisciplinary problems and networking, the intermediary role in position 3 requires an organization that is able to deliver value added by integrating client demand and market supply proactively. The developing or partnering role in position 4 requires skills and knowledge in risk management, multidisciplinary problems, strategic partnering, entrepreneurship and a business orientation. Both positions 3 and 4 require an organization that is proactively exploiting its capabilities (inside-out) instead of positions 1 and 2 who require an organization that is responding to market needs (outside-in).

Position 1, position 3 and position 4 are desired according to DHV managers, but if they would have to choose for only one position, 52% of the managers would choose for position 3 and 30% would choose for position 4 while only 11% and 7% would choose for positions 1 and 2 respectively. Positions 3 and 4 also show the highest expected profitability for DHV in a future supply-driven construction industry. Position 2 shows the lowest expectations on profitability and is also least desired and least preferred.

DHV as leading integrator or developing innovator

Altogether, the perspective of a supply-driven construction industry offers good opportunities for DHV. From the perspective that the market share of activities at the contractors’ side is growing and the market share of activities at the clients’ side is shrinking, position 4 has much potential for DHV. On the other hand, among others the interviewed managing director at DHV expects that this trend is only weak in the near future. DHV managers expect the largest organizational change for position 4, while position 3 shows a good match with the current capabilities of DHV since DHV traditionally focuses on the client side.

This indicates that position 3 is a feasible and preferred position and matches the expectations for the near future. Therefore, the primary focus on the short and middle term should be to make a change from position 1 to position 3 at the client side. DHV should take an intermediary role for clients as a leading integrator. With its two-sided knowledge and expertise, DHV must be able to look proactively for integration of demand and supply. It should proactively link appropriate solutions, technologies, or processes to problems and issues of (public) clients.

On the other hand, position 4 shows also good expectations according to DHV managers. Since DHV managers do not expect the supply-driven model to be dominant in the near future and currently DHV has too few commercial entrepreneurs and business oriented employees, position 4 is a good positioning option for a long-term strategy. Especially looking at trends like supply chain integration, integrated procurement and more unsolicited proposals, the industry is no longer characterized by fragmentation and outsourcing but instead by integration and partnering. When choosing for strategic partnering, DHV will face complications with its current status of being an independent consulting engineer.
9.2 Recommendations

A proactive attitude
In general, DHV should aim for a more proactive attitude as there is more and more room, appreciation and reward for unsolicited proposals, ideas and innovations. DHV has much potential for a more proactive position looking at the multidisciplinary knowledge, expertise, creativity and experience. Due to the fragmented approaches like responsively delivering expertise to the market wherever needed, there is too little focus on the real demand behind the actual client orders. DHV should aim to look further than its clients and try to integrate societal/market needs, trends and opportunities. More internal vision building concerning several societal issues like climate change, sustainability, transportation, mobility etc. with the help of ‘think leaders’ and ‘trend watchers’ would contribute to change to a more proactive role in the industry.

Exploit the internal capabilities
Also organizationally, DHV should incorporate this proactive attitude. Where the organization is currently shaped by projects (project-based), for more proactive concept/product development or systems integration, DHV should aim for an organization that is somewhat less project-based and more functional. DHV should aim more for exploiting internal strengths from inside out. This implies more developments independent of a specific client. As innovative concepts/solutions are commonly implemented on project level in the future supply-driven construction industry, DHV should aim for adoption of innovative concepts/solutions on firm level. This enables repetition, learning and results in lower costs and increased quality.

Innovative entrepreneurship
The level of innovative entrepreneurship of consultancy and engineering firms is determined by the involvement in activities and functions like market research, entrepreneurial corporate development, research and development, customer/end-user orientation and the level of risk-taking participation/developments. Figure 9.2 shows that the level of innovative entrepreneurship is currently limited at DHV. In order to remain in a competitive position in the supply-driven construction industry, it is essential DHV to shift from input-based (effort-based) obligations towards output-based (result-based) obligations. The interviewed managing director of DHV confirmed the strategic direction as indicated in figure 9.2.

![Figure 9.2: Characterisation of DHV's possible future positioning.](image-url)
Avoid a subcontracting role, aim for partnership or leadership
When taking a strategic position at the contractors’ side, DHV should aim to avoid a subcontracting role as capacity deliverer for the supply side (position 2). This means that DHV should take a partnering or leading role within a supply chain (or consortium) like in the fourth position as defined in this research. From the perspective that supply chains get increasingly integrated and clients aim to do business with one focal point taking overall responsibility, it seems to be inevitable that DHV should look for long-term strategic partners like several preferred partners at the contractors.

In addition, as a source of competitive advantage DHV could work with the same partners repetitively in order to gain learning effects and trust. Strategic partnering also enables to develop concepts/products with partners, which can be implemented repetitively and improved continuously. If DHV would take this strategic direction in the future it must certainly realize that the organizational culture and coordination mechanisms are rather different for the engineering dimension (consultancy and engineering) compared to the production dimension (contractors, suppliers) in construction, these functions need to be combined effectively. Where consultancy and engineering involves creativity, professionalism and mutual adjustment, production (realization) involves efficiency, capacity and standardization of work processes.

Recommendations for further research
The first recommendation is to explore the four positions as described in this study in more depth especially for the situation of DHV. When aiming for one the four positions, more in depth research and analysis into the consequences on the relationships between the 7S factors of organizations as described in chapter 8, would be valuable. Several factors could be researched systematically like mapping the current skills, management styles, type of employees, organizational structure etc. and comparing these with the required capabilities for a specific future positioning and strategy.

In addition, a recommendation is to explore whether more roles and positions could be incorporated in one business model or that there should be clearly different business models. For DHV it is important to know when and for what reasons it is inevitable to choose for separate business models or formally separate business entities.

To conclude, a recommendation is to explore internally at DHV what the differences are in opinions between employees as observed in the questionnaire survey. As the managing director stated, there seems to be a category ‘old school’ and a category ‘new school’. Mapping and linking these differences to specific business activities and disciplines might help DHV to align its business strategies to the right activities and employees.
A supply-driven construction industry for transportation infrastructure

References


Bouwend Nederland (2005), De bouw in cijfers 2000-2004, vereniging van bouw- en infrabedrijven

Bruijn, J.A. de (1996), Grote projecten: besluitvorming en management, Alphen aan de Rijn


Dorrée, A.G. (2001), Dobberen tussen concurrentie en co-development, de problematiek van samenwerking in de bouw, Intreerende Universiteit Twente, Enschede


Egan, J. (2002), Accelerating change, the strategic forum for construction, London

Lourens, E. (2006), Procesintegratie en innovatief ondernemerschap in ontwerpbureaus, Economisch Instituut voor de Bouwnijverheid, Amsterdam


Goslinga, S. (2004), De kanteling van de bouwkolom, bureau voor bouwmarketing De Bouwer & Goslinga, Weesp


A supply-driven construction industry for transportation infrastructure


Koskela, L. and Ballard, G. (2006), 'Should project management be based on theories of economics or production?', Building Research & Information, vol.34, no.2, pp.154-163


Miller, R. and Lessard, D.R. (2000), The strategic management of large engineering projects; shaping institutions risks and governance, Massachusetts Institute of Technology, pp.33-39


Morris, P.W.G. and Hough, G.H. (1987), The study of major projects, In: The anatomy of major projects; a study of the reliability of project management, John Wiley & Sons, Chichester UK, pp.3-20


OEEI (2000), research programme economic effects infrastructure, Ministry of VROM and EZ

ONRI (2000), Bureaus moeten bewuster invulling geven aan hun strategische positionering, Ministerie van economische zaken, Bedrijfstaktoets Knight Wendling

ONRI (2005), Bouworganisatie- en contractvormen: ordening, standaardisering en toepassing, organisatie van advies- en ingenieursbureaus, Den Haag


A supply-driven construction industry for transportation infrastructure


Ridder, H.A.J. de, (2006b), *Collaboration and procurement procedures in the civil engineering industry*, Faculteit civiele techniek en geowetenschappen, Delft


**Consulted websites:**

- Statistics Netherlands: [www.cbs.nl](http://www.cbs.nl)
- Dagblad voor de bouw: [www.cobouw.nl](http://www.cobouw.nl)
- Economisch Instituut voor de Bouwnijverheid: [www.eib.nl](http://www.eib.nl)
- Proces- en Systeem Innovatie in de bouw (PSIBouw): [www.psib.nl](http://www.psib.nl)
- Regieraad Bouw: [www.regieraadbouw.nl](http://www.regieraadbouw.nl)
- Rijkswaterstaat: [www.rijkswaterstaat.nl](http://www.rijkswaterstaat.nl)
- Vernieuwende bouwprojecten: [www.debouwetalage.nl](http://www.debouwetalage.nl)
- ONRI, national federation of consulting engineers: [www.onri.nl](http://www.onri.nl)
- FIDIC, international federation of consulting engineers: [www.fidic.org](http://www.fidic.org)
- UK Strategic Forum for Construction: [www.rethinkingconstruction.org](http://www.rethinkingconstruction.org)
- Strategic forum: [www.strategicforum.org.uk](http://www.strategicforum.org.uk)
- Construction industry council: [www.cic.org.uk](http://www.cic.org.uk)
- Bruggenmatrix: [www.allesoverbruggen.nl](http://www.allesoverbruggen.nl)
- Rollpave: [www.innovatieprogrammageluid.nl](http://www.innovatieprogrammageluid.nl)
Appendices

Appendix A: Organization chart DHV, Business Group: Environment and Transportation
## Appendix B: Consulted or interviewed people

<table>
<thead>
<tr>
<th>Name</th>
<th>Position</th>
<th>Business Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carlo Kuiper</td>
<td>Consultant CPM(^{19})</td>
<td>Environment &amp; Transportation</td>
</tr>
<tr>
<td>Don de Mello</td>
<td>Consultant CPM</td>
<td>Environment &amp; Transportation</td>
</tr>
<tr>
<td>Harold Wind</td>
<td>Consultant CPM</td>
<td>Environment &amp; Transportation</td>
</tr>
<tr>
<td>Eric Zonnenberg</td>
<td>Director CPM</td>
<td>Environment &amp; Transportation</td>
</tr>
<tr>
<td>Rudolf Mulder</td>
<td>Director business line Transportation</td>
<td>Environment &amp; Transportation</td>
</tr>
<tr>
<td>Guido Lahaije</td>
<td>Consultant transportation</td>
<td>Environment &amp; Transportation</td>
</tr>
<tr>
<td>Marc van Munster</td>
<td>Project manager infra-management</td>
<td>Environment &amp; Transportation</td>
</tr>
<tr>
<td>Marjolein Demmers</td>
<td>Director business line Environment &amp; Sustainability</td>
<td>Environment &amp; Transportation</td>
</tr>
<tr>
<td>Job van den Berg</td>
<td>Senior consultant DMC(^{20})</td>
<td>Environment &amp; Transportation</td>
</tr>
<tr>
<td>Hans van Engelenburg</td>
<td>Management consultant DMC</td>
<td>Environment &amp; Transportation</td>
</tr>
<tr>
<td>Patrick van Dijk</td>
<td>Management consultant DMC investment services</td>
<td>Environment &amp; Transportation</td>
</tr>
<tr>
<td>Vic Prins</td>
<td>Managing director / board</td>
<td>Environment &amp; Transportation</td>
</tr>
<tr>
<td>Martien Reniers</td>
<td>Consultant CPM</td>
<td>Environment &amp; Transportation</td>
</tr>
<tr>
<td>Koos Gloudemans</td>
<td>Human Resource consultant</td>
<td>Water</td>
</tr>
<tr>
<td>Helle van der Roest</td>
<td>Senior consultant / director DHV-Water</td>
<td>Water</td>
</tr>
<tr>
<td>Helms van der Vegte</td>
<td>Director unit Project Management</td>
<td>Buildings &amp; Industry</td>
</tr>
<tr>
<td>Donald van der Veen</td>
<td>Director ‘Schoolcompagnie’</td>
<td>Buildings &amp; Industry</td>
</tr>
</tbody>
</table>

\(^{19}\) CPM = Contract- and Project Management

\(^{20}\) DMC = DHV Management Consultants
<table>
<thead>
<tr>
<th>Name</th>
<th>Position</th>
<th>Company</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hennes de Ridder</td>
<td>Professor design and construction processes</td>
<td>TU Delft</td>
</tr>
<tr>
<td>Ruben Vrijhoef</td>
<td>Researcher</td>
<td>TU Delft</td>
</tr>
<tr>
<td>Joop Koppenjan</td>
<td>Associate professor policy, organisation and management</td>
<td>TU Delft</td>
</tr>
<tr>
<td>Donald van der Veen</td>
<td>Director Schoolcompagnie VOF</td>
<td>DHV and BAM</td>
</tr>
<tr>
<td>Eric Molin</td>
<td>University teacher research methods and data analysis</td>
<td>TU Delft</td>
</tr>
<tr>
<td>Vincent Leenders</td>
<td>Consultant</td>
<td>PtP Bouw</td>
</tr>
</tbody>
</table>

*Table B-2: Consulted or interviewed people external.*
Appendix C: Questionnaire survey DHV-Management

Dear manager/executive,

As you are holding a management/executive position at DHV in the Netherlands, you are selected and invited to participate in a DHV internal management survey. This questionnaire survey is designed as part of a graduation thesis, which I am conducting at DHV Amersfoort. This graduation thesis is the final stage in my multi-faculty masters program Transport, Infrastructure & Logistics (MSc-TIL) at Delft University of Technology. The goal of this questionnaire survey is to describe the current opinions and attitudes regarding the positioning/role and strategy at DHV in the Netherlands. The results of this questionnaire survey are confidential and intended for DHV internal use only. The inputs of individual respondents are processed anonymously. The questionnaire survey requires approximately 20 minutes.

The Dutch construction industry, and especially the civil engineering sector (GWW) is characterized by a top-down, demand-driven and responsive approach where supply follows demand (pull market). Projects are almost fully client-order-driven which means that projects are initiated and developed from concept up to realization in a unique (one-of-a-kind) manner by temporary organizations (eenmalig ambachtelijk maatwerk). Currently, the construction industry is changing and therefore this survey focuses on the possible position/role of DHV in an alternative construction industry, the ‘supply-driven’ construction industry (push market).

It is not always easy as a company to have a clear vision on the positioning and role, especially when a company is involved in many different and changing markets. Therefore this management survey, in combination with my other research findings, might enable me to identify some interesting opportunities for DHV and consequently do recommendations. Your participation in this questionnaire survey is therefore greatly appreciated!

Best regards,

Robert Kok

BG Ruimte & Mobiliteit
Unit Ontwerp & Realisatie
Afdeling Contract & Project Management, Amersfoort (B1)

KLICK OP ONDERSTAANDE LINK OM NAAR DE ENQUETE TE GAAN:

ALS DE ENQUETE NIET GEOPEND KAN WORDEN, KLICK OP PAGINA VERNIEUWEN (REFRESH) OF COPY/PASTE DE ONDERSTAANDE LINK IN DE BROWSERBALK.

http://questions.netq.nl/nq.cfm?q=7a71c858-2bf0-a000-c408-62fa53c7185c
**De toekomst van DHV**

---

<table>
<thead>
<tr>
<th>Werken aan opdrachtgeverskant (demand)</th>
<th>versus</th>
<th>Werken aan opdrachtnemerskant (supply)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reactief reageren op marktvraag (pull)</td>
<td>versus</td>
<td>Proactief marktvraag uitlokken (push)</td>
</tr>
<tr>
<td>Ondergeschikt een bijdrage leveren in projecten</td>
<td>versus</td>
<td>Risicodragend internationaal opereren</td>
</tr>
</tbody>
</table>

Geachte manager/leidinggevende,

Wat vindt u? DHV zal over 15 jaar:

- Werken aan opdrachtgeverskant (demand) versus Werken aan opdrachtnemerskant (supply)
- Reactief reageren op marktvraag (pull) versus Proactief marktvraag uitlokken (push)
- Ondergeschikt een bijdrage leveren in projecten versus Risicodragend internationaal opereren

Geef uw visie op deze vragen door deelname aan een enquête uitgevoerd als onderdeel van mijn afstudeeronderzoek aan de Technische Universiteit Delft. De enquête zal ingaan op 4 mogelijke posities/rollen voor DHV in de toekomst. Uitgangspunt is een markt die niet meer vraaggestuurd maar juist aanbodgestuurd is. Dit betekent dat de opdrachtnemerskant de opdrachtgeverskant verrast met het aanbod in plaats van dat de opdrachtgeverskant de opdrachtnemerskant verrast met de vraag.

De resultaten zijn anoniem en voor intern gebruik. Enquêtesduur is circa 20 minuten en kan in meerdere sessies ingevoerd worden. Mocht u al aan de enquête begonnen zijn, wil ik u vragen de enquête verder af te ronden.

**Klik op onderstaande link. Gebruik de knop refresh/vernieuwen als de enquête niet opent of copy/paste de link in de browserbalk**

Uw deelname wordt zeer gewaardeerd!

Met vriendelijke groet,

Robert Kok

[http://questions.netq.nl/nq.cfm?q=7a71c858-2bf0-a000-c408-62fa53c7185c](http://questions.netq.nl/nq.cfm?q=7a71c858-2bf0-a000-c408-62fa53c7185c)

N.B. Voor meer informatie zie hieronder:

BG Ruimte & Mobiliteit
Unit Ontwerp & Realisatie
Afdeling Contract & Project Management, Amersfoort (B1)

De Nederlandse bouwsector kan gekarakteriseerd worden als een top-down, vraag gestuurde en responsieve sector waar het aanbod volgt op de vraag (pull market). Projecten zijn bijna volledig klantspecifiek (opdrachtgever specifiek), hetgeen betekent dat projecten worden geïnitieerd en ontwikkeld van concept tot en met realisatie en beheer/onderhoud op een unieke wijze (one-of-a-kind) door middel van tijdelijke organisaties (eenmalig ambachtelijk maatwerk). De bouwsector is aan het veranderen (geïntegreerde contracten, ketenintegratie, totaalloplossingen, eigen initiatief) en daarom wordt in deze enquête onderzocht welke mogelijke posities DHV kan innemen in een markt die niet meer vraaggestuurd, maar aanbodgestuurd is waarin de vraag het aanbod volgt (push market).

Het is niet altijd eenvoudig voor een bedrijf om een heldere visie te hebben op de te kiezen positionering, rol en strategie, vooral wanneer je actief bent in vele verschillende en veranderende markten. Daarom kan deze managementenquête, samen met mijn andere onderzoeksbevindingen, mij mogelijk in staat stellen om enkele interessante kansen voor DHV te identificeren en vervolgens aanbevelingen te doen. Uw deelname aan de enquête wordt daarom zeer gewaardeerd!
Questionnaire

General information

1. My year of birth is: 
   19..

2. My gender is:  
   (1) Male  
   (2) Female

3. My business group is:  
   (1) Water (WA)  
   (2) Buildings & Industry (B&I)  
   (3) Environment & Transportation (RM)  
   (4) Aviation (NACO)  
   (5) DHV Holding/Other

4. My background education is:  
   (1) Business administration  
   (2) Social sciences  
   (3) Engineering and technology  
   (4) Law/legal  
   (5) A combination of these educations

Figure C-1: Screenshot questionnaire layout, DHV-management survey.
Introduction
In my graduation thesis, I describe an alternative future situation that is a supply-driven construction industry. The supply-driven construction industry operates in reversed direction compared to the traditional demand-driven construction industry and is characterized by a bottom-up, supply-driven and proactive approach where demand follows supply (based on market research and product development). In this alternative construction industry, the market has changed from a responsive pull market to a proactive push market.

The supply-driven construction industry implies that concepts/products/processes are no longer developed based on a specific client-order and for a specific project, but instead based on market research into societal/market issues, needs and trends. Examples of proactive and supply-driven developments at DHV are for instance ‘Nereda’ or ‘Ecovilla’. The supply-driven construction industry will involve total (integrated) solution providers where competition will be between supplying chains (vertically) instead of horizontal competition between consulting engineers or between contractors. For consulting engineers like DHV, four different possible positions can be identified in this alternative supply-driven situation.

These positions are presented in the quadrants below. The questionnaire is divided into four sections, each representing one of the 4 quadrants. The questions are similar in all 4 sections of this questionnaire. Each section is introduced by a short description of the possible positioning in a supply-driven construction industry. Open questions can also be answered in Dutch.

Figure C-2: Possible future positions for consulting engineers.
A) Option 1: Clients’ specialist (procurement) consulting engineer.

This quadrant represents the traditional position of a consultancy and engineering firm. Here consulting engineers are hired by clients on hours-fees basis and traditionally provide specialist advisory like planning, design, engineering or project management activities. The consulting engineer has a responsive position regarding client demand. As more design and engineering tasks are shifted towards contractors in the supply-driven construction industry, procurement advisory will become one of the most important activities at client side for consulting engineers.

A1 I think the position of clients’ specialist (procurement) consulting engineer requires DHV to have **skills and knowledge** in:

(more than one answer possible, maximum of 5 answers)
- Regulatory frameworks.
- Contracting.
- Risk management.
- Planning.
- Demand specifications (functional).
- Trend watching.
- Multidisciplinary problems.
- Networking.
- Innovation.
- Designing.
- Engineering.
- Project management.
- Tender procedures.
- Research development.
- Market research.
- Strategic partnering.
- Entrepreneurship.
- Innovation management.
- Marketing.
- Branding.
- Other, namely…
A2 I think the position of clients’ specialist (procurement) consulting engineer requires DHV to have employees who are:

(more than one answer possible, maximum of 5 answers)
- Conservative.
- Progressive.
- Client oriented.
- Contractor oriented.
- Specialists.
- Generalists.
- Mix of specialists and generalists.
- Routine oriented.
- Technical oriented.
- Efficiency oriented.
- Opportunity oriented.
- Business oriented.
- Entrepreneurial.
- Innovative.
- Proactive.
- Passive.
- Social.
- Creative.
- Collaborative.
- Other, namely….

A3 I think the position of clients’ specialist (procurement) consulting engineer requires DHV to be an organization that is:

(more than one answer possible, maximum of 3 answers)
- Responding to market needs (outside-in).
- Proactively exploiting its capabilities (inside-out).
- Shaped by projects (project-based).
- Shaped by functional departments like marketing, R&D, Engineering etc. (functional).
- Delivering value added by consultancy and engineering capacity, wherever needed.
- Delivering value added by integrating client demand and market supply (technologies) proactively.
- Delivering value added by innovative solutions.
- Other, namely…

A4 What are the most important strengths of DHV when taking this position/role?

(more than one answer possible)
- Very experienced in project management and procurement management.
- Broad knowledge in all phases of the project life cycle (integrated).
- Other, namely…
- I do not know.

A5 What are the most important weaknesses of DHV when taking this position/role?

(more than one answer possible)
- Unable to compete with other more organization and management consultants.
- No sufficient portfolio management.
- Other, namely…
- I do not know.

A6 What are the most important opportunities for DHV when taking this position/role?

(more than one answer possible)
- Procurement advisory becomes increasingly important as clients return to their core business.
- Early project involvement becomes a competitive advantage.
- Other, namely…
- I do not know.
A7 What are the most important threats for DHV when taking this position/role?
(more than one answer possible)
- Intense rivalry with other specialist (procurement) consulting engineers and thus low
  profit margins.
- Dependency on some major (public) clients like Rijkswaterstaat.
- Other, namely...
- I do not know.

A8 This position requires DHV to aim for the following competitive advantage:
(more than one answer possible, maximum of 3 answers)
- Capacity.
- Knowledge and expertise.
- Networking.
- Innovation (research & development, learning).
- Other, namely...

A9 Looking at this position for DHV, I would aim to participate more into risk-taking projects
(verschuiving van inspanningsverplichtingen naar resultaatsverplichtingen).

(1) Strongly disagree (2) Disagree (3) Neither agree nor disagree (4) Agree (5) Strongly agree

A10 I think this strategic position/role will require little organizational changes for DHV.

(1) Strongly disagree (2) Disagree (3) Neither agree nor disagree (4) Agree (5) Strongly agree

A11 If the construction industry becomes supply-driven as described in the introduction of this
questionnaire, I think this strategic position/role will be most profitable for DHV.

(1) Strongly disagree (2) Disagree (3) Neither agree nor disagree (4) Agree (5) Strongly agree
B) Option 2: Contractors’ specialist consulting engineer.

This quadrant represents the position where the consulting engineer is not hired by the client, but instead by the contractor (supply side). Consulting engineers deliver specialist capacity to the contractor and have a subcontracting responsive role in the supplying chain.

B1 I think the position of contractors’ specialist (engineering) consulting engineer requires DHV to have **skills and knowledge** in:

(more than one answer possible)
- Regulatory frameworks.
- Contracting.
- Risk management.
- Planning.
- Demand specifications (functional).
- Trend watching.
- Multidisciplinary problems.
- Networking.
- Innovation.
- Designing.
- Engineering.
- Project management.
- Tender procedures.
- Research & development.
- Market research.
- Strategic partnering.
- Entrepreneurship.
- Innovation management.
- Marketing.
- Branding.
- Other, namely...
B2 I think the position of contractors’ specialist (engineering) consulting engineer requires DHV to have employees who are:
(more than one answer possible)
- Conservative.
- Progressive.
- Client oriented.
- Contractor oriented.
- Specialists.
- Generalists.
- Mix of specialists and generalists.
- Routine oriented.
- Technical oriented.
- Efficiency oriented.
- Opportunity oriented.
- Business oriented.
- Entrepreneurial.
- Innovative.
- Proactive.
- Passive.
- Social.
- Creative.
- Collaborative.
- Other, namely….

B3 I think the position of contractors’ specialist (engineering) consulting engineer requires DHV to have an organization that is:
(more than one answer possible)
- Responding to market needs (outside-in).
- Proactively exploiting its capabilities (inside-out).
- Shaped by projects (project-based).
- Shaped by functional departments like marketing, R&D, Engineering etc. (functional).
- Delivering value added by consultancy and engineering capacity, wherever needed.
- Delivering value added by integrating client demand and market supply (technologies) proactively.
- Delivering value added by innovative solutions.
- Other, namely…

B4 What are the most important strengths of DHV when taking this position/role?
(more than one answer possible)
- Low cost engineering in GEC India.
- Broad knowledge in all phases of the project life cycle (integrated).
- Other, namely…
- I do not know.

B5 What are the most important weaknesses of DHV when taking this position/role?
(more than one answer possible)
- Culture mismatch between DHV and contractors.
- Insufficient technical expertise.
- Other, namely…
- I do not know.

B6 What are the most important opportunities for DHV when taking this position/role?
(more than one answer possible)
- Market share of design and engineering at contractors’ side is growing due to integrated contracts.
- Contractors are increasingly dependent on specialist (engineering) consulting engineers.
- Other, namely…
- I do not know.
B7 What are the most important threats for DHV when taking this position/role? (more than one answer possible)
- Intense rivalry with other contractors’ specialist consulting engineers and consequently low profit margins.
- Sub-contracting role and thus risk of being squeezed out by the contractor.
- Contractors acquire in-house specialist consulting engineers and therefore less dependent on external consulting engineers.
- Other, namely...
- I do not know.

B8 This position requires DHV to aim for the following competitive advantage: (more than one answer possible)
- Capacity.
- Knowledge and expertise.
- Networking.
- Innovation (research & development, learning).
- Other, namely...

B9 Looking at this position for DHV, I would aim to participate more into risk-taking projects (verschuiving van inspanningsverplichtingen naar resultaatsverplichtingen).

(1) Strongly disagree (2) Disagree (3) Neither agree nor disagree (4) Agree (5) Strongly agree

B10 I think this strategic position/role will require little organizational changes for DHV.

(1) Strongly disagree (2) Disagree (3) Neither agree nor disagree (4) Agree (5) Strongly agree

B11 If the construction industry becomes supply-driven as described in the introduction of this questionnaire, I think this strategic position/role will be most profitable for DHV.

(1) Strongly disagree (2) Disagree (3) Neither agree nor disagree (4) Agree (5) Strongly agree
C) Option 3: Clients’ intermediary.

This quadrant represents the position where the consulting engineer assists the client to find the best solution for the client’s problem. This intermediary consulting engineer is able to link societal issues, needs and problems (maatschappelijke vraagstukken) proactively with the solutions and technologies delivered by the supplying chains (contractors). The intermediary has a central position in society connecting the (public) clients, professional institutions (universities) and the supplying industry, and therefore able to synchronize ‘the desirable’ and ‘the possible’ within the environment and regulatory frameworks where it is used.

C1 I think the position of clients’ intermediary requires DHV to have **skills and knowledge** in: (more than one answer possible)
- Regulatory frameworks.
- Contracting.
- Risk management.
- Planning.
- Demand specifications (functional).
- Trend watching.
- Multidisciplinary problems.
- Networking.
- Innovation.
- Designing.
- Engineering.
- Project management.
- Tender procedures.
- Research & development.
- Market research.
- Strategic partnering.
- Entrepreneurship.
- Innovation management.
- Marketing.
- Branding.
- Other, namely...
C2 I think the position of clients’ intermediary requires DHV to have employees who are:

- Conservative.
- Progressive.
- Client oriented.
- Contractor oriented.
- Specialists.
- Generalists.
- Mix of specialists and generalists.
- Routine oriented.
- Technical oriented.
- Efficiency oriented.
- Opportunity oriented.
- Business oriented.
- Entrepreneurial.
- Innovative.
- Proactive.
- Passive.
- Social.
- Creative.
- Collaborative.
- Other, namely….

C3 I think the position of clients’ intermediary requires DHV to have an organization that is:

- Responding to market needs (outside-in).
- Proactively exploiting its capabilities (inside-out).
- Shaped by projects (project-based).
- Shaped by functional departments like marketing, R&D, Engineering etc. (functional).
- Delivering value added by consultancy and engineering capacity, wherever needed.
- Delivering value added by integrating client demand and market supply (technologies) proactively.
- Delivering value added by innovative solutions.
- Other, namely….

C4 What are the most important strengths of DHV when taking this position/role?

- Broad knowledge at DHV in terms of many disciplines and all project phases.
- Good relationships with all relevant actors.
- Other, namely…
- I do not know.

C5 What are the most important weaknesses of DHV when taking this position/role?

- Employees are not geared towards proactive integration of supply and demand.
- DHV’s administrative system not suitable for this role.
- Organization is not fit for this role.
- Other, namely…
- I do not know.

C6 What are the most important opportunities for DHV when taking this position/role?

- Potential clients recognize the unique position and value added of DHV and are willing to pay higher rates for these services.
- This proactive position attracts new employees.
- Other, namely…
- I do not know.
C7 What are the most important threats for DHV when taking this position/role?  
(more than one answer possible)  
- This position/role is not understood by potential clients.  
- This position/role is not recognized by potential clients.  
- Other, namely….  
- I do not know.

C8 This position requires DHV to aim for the following competitive advantage:  
(more than one answer possible)  
- Capacity.  
- Knowledge and expertise.  
- Networking.  
- Innovation (research & development, learning).  
- Other, namely…

C9 Looking at this position for DHV, I would aim to participate more into risk-taking projects  
(verschuiving van inspanningsverplichtingen naar resultaatsverplichtingen).

(1) Strongly disagree (2) Disagree (3) Neither agree nor disagree (4) Agree (5) Strongly agree

C10 I think this strategic position/role will require little organizational changes for DHV.

(1) Strongly disagree (2) Disagree (3) Neither agree nor disagree (4) Agree (5) Strongly agree

C11 If the construction industry becomes supply-driven as described in the introduction of this questionnaire, I think this strategic position/role will be most profitable for DHV.

(1) Strongly disagree (2) Disagree (3) Neither agree nor disagree (4) Agree (5) Strongly agree

This quadrant represents a position where the consulting engineer has a proactive position at the supply side (contractors). The consulting engineer has a leading or partnering role in developing and offering totally integrated solutions (concepts/products). Strategic partnering between consulting engineers, contractors, component suppliers, element suppliers etc. enables to develop concepts/products (families) that can be repetitively implemented on several projects.

D1 I think the position of integrated concept/product developer, partner in consortia, requires DHV to have **skills and knowledge** in:

(more than one answer possible)

- Regulatory frameworks.
- Contracting.
- Risk management.
- Planning.
- Demand specifications (functional).
- Trend watching.
- Multidisciplinary problems.
- Networking.
- Innovation.
- Designing.
- Engineering.
- Project management.
- Tender procedures.
- Research & development.
- Market research.
- Strategic partnering.
- Entrepreneurship.
- Innovation management.
- Marketing.
- Branding.
- Other, namely...
D2  I think the position of integrated concept/product developer, partner in consortia, requires DHV to have **employees** who are:
(more than one answer possible)
- Conservative.
- Progressive.
- Client oriented.
- Contractor oriented.
- Specialists.
- Generalists.
- Mix of specialists and generalists.
- Routine oriented.
- Technical oriented.
- Efficiency oriented.
- Opportunity oriented.
- Business oriented.
- Entrepreneurial.
- Innovative.
- Proactive.
- Passive.
- Social.
- Creative.
- Collaborative.
- Other, namely…

D3  I think the position of integrated concept/product developer, partner in consortia, requires DHV to have an **organization** that is:
(more than one answer possible)
- Responding to market needs (outside-in).
- Proactively exploiting its capabilities (inside-out).
- Shaped by projects (project-based).
- Shaped by functional departments like marketing, R&D, Engineering etc. (functional).
- Delivering value added by consultancy and engineering capacity, wherever needed.
- Delivering value added by integrating client demand and market supply (technologies) proactively.
- Delivering value added by innovative solutions.
- Other, namely…

D4  What are the most important **strengths** of DHV when taking this position/role?
(more than one answer possible)
- Broad knowledge and expertise is available to develop new concepts/products.
- DHV has experience from both a client perspective as well as from a contractor perspective. This might enable DHV to take a participative role or even a leading role within a consortium or supply chain.
- Other, namely…
- I do not know.

D5  What are the most important **weaknesses** of DHV when taking this position/role?
(more than one answer possible)
- Investments very risky due to the ‘short’ balance sheet.
- Employees are not geared towards proactive concept/product development (inside-out).
- Unfamiliar with marketing and branding of products/concepts.
- DHV is typically project-based. This type of position requires a more functional organization.
- Other, namely…
- I do not know.
D6  What are the most important **opportunities** for DHV when taking this position/role? (more than one answer possible)
- Market shift from a lowest price system to a quality system, so innovation is rewarded.
- First mover advantage.
- Clients increasingly demand totally integrated solutions and one focal point for their product/service delivery.
- Other, namely...
- I do not know.

D7  What are the most important **threats** for DHV when taking this position/role? (more than one answer possible)
- Other rivals (vertical and horizontal competition).
- There is no demand (or overestimated) for DHV’s products/concepts.
- Other, namely...
- I do not know.

D8  This position requires DHV to aim for the following **competitive advantage**: (more than one answer possible)
- Capacity.
- Knowledge and expertise.
- Networking.
- Innovation (research & development, learning).
- Other, namely…

D9  Looking at this position for DHV, I would aim to participate more into risk-taking projects (verschuiving van inspanningsverplichtingen naar resultaatsverplichtingen).

(1) Strongly disagree (2) Disagree (3) Neither agree nor disagree (4) Agree (5) Strongly agree

D10  I think this strategic position/role will require little organizational changes for DHV.

(1) Strongly disagree (2) Disagree (3) Neither agree nor disagree (4) Agree (5) Strongly agree

D11  If the construction industry becomes supply-driven as described in the introduction of this questionnaire, I think this strategic position/role will be most profitable for DHV.

(1) Strongly disagree (2) Disagree (3) Neither agree nor disagree (4) Agree (5) Strongly agree
E) Conclusion

Now that you have finished the questions regarding the 4 positions for DHV in a supply-driven market, some concluding questions are asked to see what you would prefer from a DHV board of directors perspective. What strategic position/role for DHV would you prefer in a market that has changed from a (traditional) responsive, demand-driven pull market, to a proactive, supply-driven push market?

E1 I think the position of clients’ specialist (procurement) consulting engineer is:

(1) Highly undesirable (2) Undesirable (3) Neither undesirable nor desirable (4) Desirable (5) Highly desirable

E2 I think the position of contractors’ specialist (engineering) consulting engineer is:

(1) Highly undesirable (2) Undesirable (3) Neither undesirable nor desirable (4) Desirable (5) Highly desirable

E3 I think the position of clients’ intermediary is:

(1) Highly undesirable (2) Undesirable (3) Neither undesirable nor desirable (4) Desirable (5) Highly desirable

E4 I think the position of integrated concept/product developer, partner in consortia is:

(1) Highly undesirable (2) Undesirable (3) Neither undesirable nor desirable (4) Desirable (5) Highly desirable

E5 If you would have to choose one of the 4 positions/roles for DHV being most desirable, which one would you choose?

- Clients’ specialist (procurement) consulting engineer.
- Contractors’ specialist (engineering) consulting engineer.
- Clients’ intermediary.
- Concept/product developer, partner in consortia, total solution provider.

E6 What are the three most important reasons why you chose this most desirable position?

- Competitive position of DHV.
- Profitability of DHV.
- Continuity of DHV.
- Internationalization.
- Other, namely...
- I do not know.

E7 If you have any remarks or suggestions, please use the space below.

Thank you for your time and cooperation!
Appendix D: Questionnaire descriptives

### Table D-1: Age descriptives DHV-management survey.

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>47.4</td>
<td></td>
</tr>
<tr>
<td>Min</td>
<td>35</td>
<td></td>
</tr>
<tr>
<td>Max</td>
<td>61</td>
<td></td>
</tr>
</tbody>
</table>

### Table D-2: Gender descriptives DHV-management survey.

<table>
<thead>
<tr>
<th>Gender</th>
<th>Number</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>23</td>
<td>85%</td>
</tr>
<tr>
<td>Female</td>
<td>4</td>
<td>15%</td>
</tr>
</tbody>
</table>

### Table D-3: Business group descriptives DHV-management survey.

<table>
<thead>
<tr>
<th>Business group</th>
<th>Number</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Environment &amp; Transportation</td>
<td>21</td>
<td>78%</td>
</tr>
<tr>
<td>Buildings &amp; Industry</td>
<td>5</td>
<td>19%</td>
</tr>
<tr>
<td>Water</td>
<td>1</td>
<td>4%</td>
</tr>
<tr>
<td>Aviation</td>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td>Holding</td>
<td>0</td>
<td>0%</td>
</tr>
</tbody>
</table>

### Table D-4: Background education descriptives DHV-management survey.

<table>
<thead>
<tr>
<th>Background education</th>
<th>Number</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Business administration</td>
<td>1</td>
<td>4%</td>
</tr>
<tr>
<td>Social sciences</td>
<td>3</td>
<td>11%</td>
</tr>
<tr>
<td>Engineering &amp; Technology</td>
<td>18</td>
<td>67%</td>
</tr>
<tr>
<td>Law/legal</td>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td>Combination of these educations</td>
<td>5</td>
<td>19%</td>
</tr>
</tbody>
</table>

### Table D-5: Descriptives of participation into more risk-taking projects (verschuiving van inspanningsverplichtingen naar resultaatsverplichtingen).

<table>
<thead>
<tr>
<th></th>
<th>Strongly disagree</th>
<th>Disagree</th>
<th>Neither (dis)agree</th>
<th>Agree</th>
<th>Strongly agree</th>
<th>Mean</th>
<th>Standard deviation σ</th>
</tr>
</thead>
<tbody>
<tr>
<td>Position 1</td>
<td>1 4%</td>
<td>5 19%</td>
<td>5 19%</td>
<td>9 35%</td>
<td>6 23%</td>
<td>3.5</td>
<td>1.2</td>
</tr>
<tr>
<td>Position 2</td>
<td>1 4%</td>
<td>5 19%</td>
<td>1 4%</td>
<td>17 63%</td>
<td>3 11%</td>
<td>3.6</td>
<td>1.0</td>
</tr>
<tr>
<td>Position 3</td>
<td>2 7%</td>
<td>3 11%</td>
<td>6 22%</td>
<td>14 52%</td>
<td>2 7%</td>
<td>3.4</td>
<td>1.0</td>
</tr>
<tr>
<td>Position 4</td>
<td>0 0%</td>
<td>1 4%</td>
<td>7 26%</td>
<td>16 59%</td>
<td>3 11%</td>
<td>3.8</td>
<td>0.7</td>
</tr>
</tbody>
</table>

### Table D-6: Descriptives of expected required organizational change.

<table>
<thead>
<tr>
<th></th>
<th>Strongly disagree</th>
<th>Disagree</th>
<th>Neither (dis)agree</th>
<th>Agree</th>
<th>Strongly agree</th>
<th>Mean</th>
<th>Standard deviation σ</th>
</tr>
</thead>
<tbody>
<tr>
<td>Position 1</td>
<td>2 8%</td>
<td>6 23%</td>
<td>6 23%</td>
<td>11 42%</td>
<td>1 4%</td>
<td>3.1</td>
<td>1.1</td>
</tr>
<tr>
<td>Position 2</td>
<td>1 4%</td>
<td>9 33%</td>
<td>5 19%</td>
<td>11 41%</td>
<td>1 4%</td>
<td>3.1</td>
<td>1.0</td>
</tr>
<tr>
<td>Position 3</td>
<td>2 7%</td>
<td>9 33%</td>
<td>2 7%</td>
<td>13 48%</td>
<td>1 4%</td>
<td>3.1</td>
<td>1.1</td>
</tr>
<tr>
<td>Position 4</td>
<td>6 22%</td>
<td>8 30%</td>
<td>4 15%</td>
<td>5 19%</td>
<td>4 15%</td>
<td>2.7</td>
<td>1.4</td>
</tr>
</tbody>
</table>
A supply-driven construction industry for transportation infrastructure

<table>
<thead>
<tr>
<th>Strongly disagree</th>
<th>Disagree</th>
<th>Neither (dis)agree</th>
<th>Agree</th>
<th>Strongly agree</th>
<th>Mean</th>
<th>Standard deviation σ</th>
</tr>
</thead>
<tbody>
<tr>
<td>Position 1</td>
<td>0  0%</td>
<td>9  35%</td>
<td>6  23%</td>
<td>11  42%</td>
<td>0  0%</td>
<td>3.1</td>
</tr>
<tr>
<td>Position 2</td>
<td>2  7%</td>
<td>9  33%</td>
<td>10  37%</td>
<td>5  19%</td>
<td>1  4%</td>
<td>2.8</td>
</tr>
<tr>
<td>Position 3</td>
<td>0  0%</td>
<td>4  15%</td>
<td>11  41%</td>
<td>9  33%</td>
<td>3  11%</td>
<td>3.4</td>
</tr>
<tr>
<td>Position 4</td>
<td>0  0%</td>
<td>4  15%</td>
<td>13  48%</td>
<td>9  33%</td>
<td>1  4%</td>
<td>3.3</td>
</tr>
</tbody>
</table>

Table D-7: Descriptives of the expected profitability per position for DHV.

<table>
<thead>
<tr>
<th>Skills and Knowledge</th>
<th>%*</th>
<th>Employees</th>
<th>%*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Position 1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1) Project management</td>
<td>58%</td>
<td>1) Client oriented</td>
<td>73%</td>
</tr>
<tr>
<td>2) Contracting</td>
<td>54%</td>
<td>2) Mix of specialist and generalist</td>
<td>58%</td>
</tr>
<tr>
<td>3) Risk management</td>
<td>50%</td>
<td>3) Proactive</td>
<td>42%</td>
</tr>
<tr>
<td>4) Tender procedures</td>
<td>46%</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>4) Regulatory frameworks</td>
<td>46%</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Position 2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1) Engineering</td>
<td>74%</td>
<td>1) Technical oriented</td>
<td>67%</td>
</tr>
<tr>
<td>2) Designing</td>
<td>59%</td>
<td>2) Specialist</td>
<td>48%</td>
</tr>
<tr>
<td>3) Risk management</td>
<td>41%</td>
<td>3) Contractor oriented</td>
<td>44%</td>
</tr>
<tr>
<td>4) Innovative</td>
<td>-</td>
<td>3) Efficiency oriented</td>
<td>44%</td>
</tr>
<tr>
<td></td>
<td>-</td>
<td>3) Proactive</td>
<td>44%</td>
</tr>
<tr>
<td></td>
<td>-</td>
<td>4) Innovative</td>
<td>41%</td>
</tr>
<tr>
<td>Position 3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1) Multidisciplinary problems</td>
<td>56%</td>
<td>1) Client oriented</td>
<td>78%</td>
</tr>
<tr>
<td>2) Networking</td>
<td>44%</td>
<td>2) Proactive</td>
<td>48%</td>
</tr>
<tr>
<td>3) Strategic partnering</td>
<td>41%</td>
<td>2) Mix of specialist and generalist</td>
<td>48%</td>
</tr>
<tr>
<td>3) Risk management</td>
<td>41%</td>
<td>3) Opportunity oriented</td>
<td>44%</td>
</tr>
<tr>
<td>4) Innovative</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Position 4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1) Risk management</td>
<td>52%</td>
<td>1) Entrepreneurial</td>
<td>63%</td>
</tr>
<tr>
<td>2) Multidisciplinary problems</td>
<td>48%</td>
<td>2) Business oriented</td>
<td>56%</td>
</tr>
<tr>
<td>3) Strategic partnering</td>
<td>44%</td>
<td>2) Mix of specialist and generalist</td>
<td>56%</td>
</tr>
<tr>
<td>4) Entrepreneurship</td>
<td>41%</td>
<td>3) Proactive</td>
<td>48%</td>
</tr>
<tr>
<td></td>
<td>-</td>
<td>4) Opportunity oriented</td>
<td>41%</td>
</tr>
<tr>
<td></td>
<td>-</td>
<td>4) Innovative</td>
<td>41%</td>
</tr>
</tbody>
</table>

Table D-8: General requirement regarding skills & knowledge and employees per position.

* All items that are stated by more than 40% of the respondents are included in the table.

<table>
<thead>
<tr>
<th>Organization</th>
<th>%*</th>
<th>Competitive advantage</th>
<th>%*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Position 1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1) Responding to market needs (outside-in)</td>
<td>69%</td>
<td>1) Knowledge and expertise</td>
<td>85%</td>
</tr>
<tr>
<td>2) Shaped by projects (project-based)</td>
<td>58%</td>
<td>2) Capacity</td>
<td>50%</td>
</tr>
<tr>
<td>Position 2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1) Shaped by projects (project-based)</td>
<td>59%</td>
<td>1) Knowledge and expertise</td>
<td>89%</td>
</tr>
<tr>
<td>2) Delivering value added by consultancy and engineering capacity, wherever needed</td>
<td>48%</td>
<td>2) Capacity</td>
<td>44%</td>
</tr>
<tr>
<td>3) Responding to market needs (outside-in)</td>
<td>44%</td>
<td>3) Innovation (R&amp;D, learning)</td>
<td>41%</td>
</tr>
<tr>
<td>Position 3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1) Proactively exploiting its capabilities (inside-out)</td>
<td>59%</td>
<td>1) Networking</td>
<td>85%</td>
</tr>
<tr>
<td>1) Delivering value added by integrating client demand and market supply (technologies) proactively</td>
<td>59%</td>
<td>2) Knowledge and expertise</td>
<td>74%</td>
</tr>
<tr>
<td>2) Responding to market needs (outside-in)</td>
<td>48%</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Position 4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1) Proactively exploiting its capabilities (inside-out)</td>
<td>81%</td>
<td>1) Knowledge and expertise</td>
<td>78%</td>
</tr>
<tr>
<td>2) Delivering value added by innovative solutions</td>
<td>52%</td>
<td>2) Innovation (R&amp;D, learning)</td>
<td>67%</td>
</tr>
<tr>
<td>3) Delivering value added by integrating client demand and market supply (technologies) proactively</td>
<td>41%</td>
<td>3) Networking</td>
<td>48%</td>
</tr>
</tbody>
</table>

Table D-9: General requirement regarding organization and competitive advantage per position.

* All items that are stated by more than 40% of the respondents are included in the table.
### Table D-10: Descriptives of the desirability per position for DHV.

<table>
<thead>
<tr>
<th>Position</th>
<th>Strongly disagree</th>
<th>Disagree</th>
<th>Neither (dis)agree</th>
<th>Agree</th>
<th>Strongly agree</th>
<th>Mean</th>
<th>Standard deviation</th>
<th>σ</th>
</tr>
</thead>
<tbody>
<tr>
<td>Position 1</td>
<td>0</td>
<td>0%</td>
<td>3</td>
<td>11%</td>
<td>3</td>
<td>11%</td>
<td>17</td>
<td>63%</td>
</tr>
<tr>
<td>Position 2</td>
<td>1</td>
<td>4%</td>
<td>9</td>
<td>33%</td>
<td>2</td>
<td>7%</td>
<td>15</td>
<td>56%</td>
</tr>
<tr>
<td>Position 3</td>
<td>0</td>
<td>0%</td>
<td>3</td>
<td>11%</td>
<td>3</td>
<td>11%</td>
<td>13</td>
<td>48%</td>
</tr>
<tr>
<td>Position 4</td>
<td>0</td>
<td>0%</td>
<td>4</td>
<td>15%</td>
<td>9</td>
<td>33%</td>
<td>10</td>
<td>37%</td>
</tr>
</tbody>
</table>

### Table D-11: Frequency and percentage of DHV-management choosing for one position.

<table>
<thead>
<tr>
<th>Position</th>
<th>Number</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Position 1</td>
<td>3</td>
<td>11%</td>
</tr>
<tr>
<td>Position 2</td>
<td>2</td>
<td>7%</td>
</tr>
<tr>
<td>Position 3</td>
<td>14</td>
<td>52%</td>
</tr>
<tr>
<td>Position 4</td>
<td>8</td>
<td>30%</td>
</tr>
</tbody>
</table>

### Table D-12: Most important reasons to choose for this most preferred future position.

<table>
<thead>
<tr>
<th>Reason</th>
<th>Number</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Competitive position of DHV</td>
<td>22</td>
<td>81%</td>
</tr>
<tr>
<td>Profitability of DHV</td>
<td>17</td>
<td>63%</td>
</tr>
<tr>
<td>Internationalization</td>
<td>9</td>
<td>33%</td>
</tr>
<tr>
<td>Continuity of DHV</td>
<td>8</td>
<td>30%</td>
</tr>
<tr>
<td>Innovative</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>Fun</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>Personal challenge</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>Value added of DHV are 'people', production of products requires lean company</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>Best combination of DHV strengths, culture and market trends</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>Initiating new developments</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>Spin off</td>
<td>1</td>
<td>-</td>
</tr>
</tbody>
</table>
### SWOT of position 1, clients’ specialist (procurement) consulting engineer:

<table>
<thead>
<tr>
<th><strong>Strength</strong></th>
<th><strong>Number</strong></th>
<th><strong>Percentage</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Very experienced in project management and procurement management</td>
<td>20</td>
<td>77%</td>
</tr>
<tr>
<td>Broad knowledge in all phases of the project life-cycle (integrated)</td>
<td>17</td>
<td>65%</td>
</tr>
<tr>
<td>Integrity/Transparency</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>Able to combine content and process, specialist knowledge and customer context</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>Specialists available in the business line of the project manager</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>I do not know</td>
<td>1</td>
<td>4%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Weaknesses</strong></th>
<th><strong>Number</strong></th>
<th><strong>Percentage</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>No sufficient portfolio management</td>
<td>12</td>
<td>46%</td>
</tr>
<tr>
<td>Unable to compete with other more organizations and management consultants</td>
<td>5</td>
<td>19%</td>
</tr>
<tr>
<td>Branding, marketing (insufficient)</td>
<td>2</td>
<td>-</td>
</tr>
<tr>
<td>Management capabilities</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>Highly dependent on clients</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>Unwilling to take risks in projects</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>Little chance to promote your skills and knowledge</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>Delivering either specialist or process services instead of an integral approach</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>Ability to change rates/fees in comparison with competitors</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>High hourly rates</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>Capacity</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>No culture of standard methodologies</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>DHV company too small</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>Unaware of its strengths</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>Lack of creativeness to win</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>Broad focus, account management</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>Size of the company (to slow to follow the market quicker)</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>I do not know</td>
<td>3</td>
<td>12%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Opportunities</strong></th>
<th><strong>Number</strong></th>
<th><strong>Percentage</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Procurement advisory becomes increasingly important as clients return to their core business</td>
<td>14</td>
<td>54%</td>
</tr>
<tr>
<td>Early project involvement becomes a competitive advantage</td>
<td>12</td>
<td>46%</td>
</tr>
<tr>
<td>Very good market gives opportunities to take over smaller companies (strong niches)</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>Networking with suppliers</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>Earning client-trust to do more jobs in the future</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>Tendency of outsourcing/tendering larger or integral packages of advisory services</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>Involvement in new trends as competitive edge</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>Being able to deliver a much wider spectrum of services than specialized project management and procurement advisory organizations</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>I do not know</td>
<td>3</td>
<td>12%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Threats</strong></th>
<th><strong>Number</strong></th>
<th><strong>Percentage</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Dependency on some major (public) clients like Rijkswaterstaat</td>
<td>12</td>
<td>46%</td>
</tr>
<tr>
<td>Intense rivalry with other specialist (procurement) consulting engineers and thus low profit margins</td>
<td>9</td>
<td>35%</td>
</tr>
<tr>
<td>DHV is currently not able to operate as a real network organization, partly because of an aged business model that is not suited to current market needs</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>Continuous search for new approaches</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>Dependency on economic climate</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>Loss of the engineering capability</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>DHV is not always innovative enough in their solutions</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>That we not adjust quick enough to the chancing of the market</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>Slow growth</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>No real in-house experience</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>I do not know</td>
<td>2</td>
<td>8%</td>
</tr>
</tbody>
</table>

Table E-1: Full SWOT analysis of DHV for position 1: Clients’ specialist (procurement) consultant.
### SWOT of position 2, contractors’ specialist (engineering) consulting engineer:

#### Strength

<table>
<thead>
<tr>
<th></th>
<th>Number</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Broad knowledge in all phases of the project life-cycle (integrated)</td>
<td>19</td>
<td>70%</td>
</tr>
<tr>
<td>Low cost engineering in India</td>
<td>17</td>
<td>63%</td>
</tr>
<tr>
<td>Innovative, which brings value added to the contractor’s chances in the market</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>Brand name in the market of DHV</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>Specialists</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>Top technological know how to provide competitive edge in DB-projects</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>Strong back office</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>Commitment</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>I do not know</td>
<td>1</td>
<td>4%</td>
</tr>
</tbody>
</table>

#### Weaknesses

<table>
<thead>
<tr>
<th></th>
<th>Number</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Culture mismatch between DHV and contractors</td>
<td>23</td>
<td>85%</td>
</tr>
<tr>
<td>Insufficient technical expertise</td>
<td>8</td>
<td>30%</td>
</tr>
<tr>
<td>To do only what is asked</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>Price of high rates</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>Project and quality control</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>Not efficiency oriented</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>Non-industrial image</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>Little focus on engineering production and capacity</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>I do not know</td>
<td>1</td>
<td>4%</td>
</tr>
</tbody>
</table>

#### Opportunities

<table>
<thead>
<tr>
<th></th>
<th>Number</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Market share of design and engineering at contractors’ side is growing due to integrated contracts</td>
<td>19</td>
<td>70%</td>
</tr>
<tr>
<td>Contractors are increasingly dependent on specialist (engineering) consulting engineers</td>
<td>12</td>
<td>44%</td>
</tr>
<tr>
<td>Contractors’ lack of specific expertise like planning procedures, permits, noise etc.</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>I do not know</td>
<td>2</td>
<td>7%</td>
</tr>
</tbody>
</table>

#### Threats

<table>
<thead>
<tr>
<th></th>
<th>Number</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subcontracting role and thus risk of being squeezed out by the contractor</td>
<td>21</td>
<td>78%</td>
</tr>
<tr>
<td>Contractors acquire in-house specialist consulting engineers and therefore less dependent on external consulting engineers</td>
<td>11</td>
<td>41%</td>
</tr>
<tr>
<td>Intense rivalry with other contractors’ specialist (engineering) consulting engineers and consequently low profit margins</td>
<td>6</td>
<td>22%</td>
</tr>
<tr>
<td>Lack of authority or control</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>No positive experience</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>Man-capacity</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>I do not know</td>
<td>2</td>
<td>7%</td>
</tr>
</tbody>
</table>

*Table E-2: Full SWOT analysis of DHV for position 2: Contractors’ specialist (engineering) consultant.*
### SWOT of position 3, clients’ intermediary:

<table>
<thead>
<tr>
<th>Strength</th>
<th>Number</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Good relationships with all relevant actors</td>
<td>26</td>
<td>96%</td>
</tr>
<tr>
<td>Broad knowledge at DHV in terms of many disciplines in all project phases</td>
<td>20</td>
<td>74%</td>
</tr>
<tr>
<td>All disciplines in-house</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>Knowing what societal/market issues are present</td>
<td>1</td>
<td>-</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Weaknesses</th>
<th>Number</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Employees are not geared towards proactive integration of supply and demand</td>
<td>19</td>
<td>70%</td>
</tr>
<tr>
<td>Organization is not fit for this role</td>
<td>5</td>
<td>19%</td>
</tr>
<tr>
<td>DHV’s administrative system is not suitable for this role</td>
<td>2</td>
<td>7%</td>
</tr>
<tr>
<td>Risk of lots of talk and little results</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>Finding the mix between client orientation and providing critical but positive solutions</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>Requires a different attitude than usually</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>I do not know</td>
<td>3</td>
<td>11%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Opportunities</th>
<th>Number</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Potential clients recognize the unique position and value added of DHV and are willing to pay higher rates for these services</td>
<td>22</td>
<td>81%</td>
</tr>
<tr>
<td>This proactive position attracts new employees</td>
<td>19</td>
<td>70%</td>
</tr>
<tr>
<td>Early project involvement</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>If once successful, a client will not forget this and hires us again</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>I do not know</td>
<td>1</td>
<td>4%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Threats</th>
<th>Number</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>This position/role is not recognized by potential clients</td>
<td>17</td>
<td>63%</td>
</tr>
<tr>
<td>This position/role is not understood by potential clients</td>
<td>6</td>
<td>22%</td>
</tr>
<tr>
<td>Doubtful whether the market is ready for this position</td>
<td>2</td>
<td>-</td>
</tr>
<tr>
<td>Not able to fulfill all requirements and expectations in the whole chain</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>Difficult to show value added/specific strengths relative to competition</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>Sales depends on individual relations and one-to-one contracts (limited leverage)</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>I do not know</td>
<td>1</td>
<td>4%</td>
</tr>
</tbody>
</table>

*Table E-3: Full SWOT analysis of DHV for position 3: Clients’ intermediary.*
SWOT of position 4, integrated concept/product developer, partner in consortia:

<table>
<thead>
<tr>
<th>Strength</th>
<th>Number</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>DHV has experience from both a client perspective as well as from a contractor perspective. This might enable DHV to take a participative or even a leading role within a consortium or supply chain</td>
<td>19</td>
<td>70%</td>
</tr>
<tr>
<td>Broad knowledge and expertise is available to develop new concepts/products</td>
<td>16</td>
<td>59%</td>
</tr>
<tr>
<td>Out of the box thinking</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>DHV must take a leading role to cope with risks</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>I do not know</td>
<td>0</td>
<td>0%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Weaknesses</th>
<th>Number</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Investments very risky due to `short balance sheet</td>
<td>14</td>
<td>52%</td>
</tr>
<tr>
<td>Employees are not geared towards proactive concept/product development</td>
<td>12</td>
<td>44%</td>
</tr>
<tr>
<td>Unfamiliar with marketing and branding of products/concepts</td>
<td>12</td>
<td>44%</td>
</tr>
<tr>
<td>DHV is typically project-based. This type of position requires a more functional organization</td>
<td>9</td>
<td>33%</td>
</tr>
<tr>
<td>Seeing threats instead of opportunities</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>Non-entrepreneurs organization</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>Better become part of a supplier (vertical integrated supply model)</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>I do not know</td>
<td>0</td>
<td>0%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Opportunities</th>
<th>Number</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clients increasingly demand totally integrated solutions and one focal point for their product/service delivery</td>
<td>17</td>
<td>63%</td>
</tr>
<tr>
<td>Market shift from a lowest price system to a quality system, so innovation is rewarded</td>
<td>15</td>
<td>56%</td>
</tr>
<tr>
<td>First mover advantage</td>
<td>7</td>
<td>26%</td>
</tr>
<tr>
<td>Repetitively selling one product</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>I do not know</td>
<td>1</td>
<td>4%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Threats</th>
<th>Number</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Other rivals (vertical and horizontal competition)</td>
<td>16</td>
<td>59%</td>
</tr>
<tr>
<td>There is no (or overestimated) demand for DHV’s concepts/products</td>
<td>11</td>
<td>41%</td>
</tr>
<tr>
<td>Risk management is not ok</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>No accepted concepts of supply driven business in infrastructure business as yet</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>Increased influence of tenders and procurement officers combined with increased competition makes market shift towards a lowest price system</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>I do not know</td>
<td>3</td>
<td>11%</td>
</tr>
</tbody>
</table>

Table E-4: Full SWOT analysis of DHV for position 4: Integrated concept/product developer, partner in consortia.
Introduction:
Amersfoort, 13th of July 2007: The interview started with a brief introduction of the research objective, main research question and interview topics. Then the conceptual model of a supply-driven construction industry was explained as a conceptual framework for the interview questions. Last part of the introduction involved the explanation of the four future positioning options for DHV in a supply-driven construction industry.

- Responsive (capacity deliverer)
- Proactive (developing and integrating systems)
- Demand side (clients)
- Supply side (contractors)

Figure F-1: Possible future positions for consulting engineers.

Interview:
RK21: Ik wil u allereerst vragen onderstaande citaat te lezen.

“….. daartegenover staan fikse projectverliezen en -voorzieningen. Deze kwamen vooral voort uit ons werk met aannemers, waarbij project X een belangrijk aandeel had. We zullen in de toekomst vaker met/voor aannemers gaan werken en we zullen er onze manier van werken op moeten gaan aanpassen. De indruk bij project X is dat de aannemercombinatie niet acteert als professionele opdrachtgever. DHV wordt gezien als onderaannemer, die moet leveren en verder niet zeuren. Dit is niet het geval bij alle werken die we met aannemers doen, maar het is wel iets waarvan we kunnen verwachten dat het vaker voor gaat komen in de toekomst. Bij een opdracht als project X moeten we meer aan het stuur komen. Dit vraagt van de aannemers dat ze DHV meer gaan zien als partner en van ons dat wij beter begrijpen wat een aannemer beweegt. De aannemer werkt volgens strakke deadlines, waar wij ook aan zullen moeten voldoen. Snel reageren is dan ook een vereiste. Er wordt van ons verwacht dat we veel aandacht geven aan planning en aan kwaliteitscontrole en dat we voortdurend meedenken in het maken van optimalisatieslagen. Het zijn allemaal dingen die we goed kunnen, maar, onder de druk van een moeilijk lopend project, niet altijd doen. Project X is een leerproces en ik ben ervan overtuigd dat we er goed uit gaan komen, maar laten we ook echt leren van de ervaringen en onze werkwijzen gaan aanpassen zodat we in de toekomst beter gesteld staan om deel te nemen in werken met aannemercombinaties.”

Rudolf Mulder (director business line Transportation)

21 RK = Robert Kok, VP = Vic Prins
RK: Dit citaat is het toonbeeld van DHV in positie 2. DHV wordt gezien als onderaannemer die (capaciteit) moet leveren en niet moet zeuren. DHV zit weggedrukt in een ondergeschikte positie terwijl DHV juist meer aan stuur wil komen. DHV heeft duidelijk aanpassingsproblemen in deze rol. Aannemers zijn gefocust op efficiency en resultaten (targets en deadlines). Dit wijst duidelijk op een mismatch van bedrijfsculturen die ook door DHV managers in de enquête als zwak punt wordt genoemd. DHV wil liever gezien worden als partner of misschien wel als leidende speler in een consortium. Dit wijst in de richting van positie 4. Gaat DHV verschuiven naar positie 4?

VP: Ervaring (o.a. in Zuid Afrika) leert dat positie 4 ook valkuilen heeft. Om een leidende positie in te nemen in een aannemersconsortium blijven de financiën bepalend. De financiële rol van DHV is klein in deze combinaties waardoor DHV te weinig ‘muscle’ heeft en dus een mindere rol bedeeld krijgt. Daarnaast wil de aannemer graag zijn eigen spel spelen en ontstaat er een machtstrijd. In Zuid Afrika heb ik juist een omgekeerde beweging gezien van positie 4 naar positie 2.

RK: Een kleine ondergeschikte rol lijkt erg paradoxaal, want de conceptuele en intellectuele inbreng van de adviseurs/DHV is juist zo groot. Positie 2 en 4 hebben allebei dus voor- en nadelen, maar welke kant moet DHV op? Gaat DHV inzetten op meer financiële inbreng in projecten om een leidende rol te nemen in positie 4? Of gaat DHV zich volledig aanpassen aan de aannemers in positie 2?

VP: Dit is inderdaad een paradox. In Noord-Amerika hebben advies- en ingenieursbureaus zich financieel sterker gemaakt. DHV wil die kant op dit moment niet op. DHV moet in ieder geval niet in een ondergeschikte rol terechtkomen, maar een partner worden. Dit is ook beter voor het eindproduct.

RK: Betekent het werken als partner aan aannemerszijde dat DHV zich moet schikken naar de cultuur van de aannemers, of juist andersom?

VP: Vooroordelen en verschillen in cultuur moeten overbruggd worden. Zowel de aannemers als DHV moeten een omslag maken.

VP: Ten aanzien van dat aanbodgestuurde model betekent dat meer ‘Siemens’ bedrijven. Ook DHV maakt die sprong met een software product van DHV dochter Delcan in Noord-Amerika. Hier gaat het om verkeerssystemen (IT) die voorheen 100% maatwerk (klantspecifiek) waren. Inmiddels is er een standaard pakket dat voor 80% gestandaardiseerd is en slechts voor 20% klantspecifiek. De implementatie is hierdoor verkort van 9 maanden naar 3 maanden en daardoor erg succesvol.

RK: In de management enquête kwam naar voren dat men gemiddeld meer risicodragend wil participeren in projecten met name ten aanzien van de vierde positie. Moet DHV meer risicodragend participeren?

VP: Risico’s moeten voor DHV beheersbaar zijn. Door veel kennis en ervaring is DHV bijvoorbeeld in staat risico’s te dragen bij een watervoorzieningsproject in Taiwan dat meer output-based is. Er moet continu een balans gezocht worden tussen de risico’s die gedragen kunnen worden en de financiële positie.

RK: De huidige civiele bouw wordt gekenmerkt door het project-denken (eenmalig ambachtelijk maatwerk), terwijl een proactief aanbieder in de aanbodgestuurde bouw van de toekomst juist meer het productie perspectief moet hebben (product development, product families, continuous improvement). Gaat DHV in de toekomst strategische (langdurige) samenwerkingen aan met aanbiedende partijen/aannemers om totaaloplossingen te kunnen aanbieden?
VP: Mijn verwachting is dat het wel die kant op gaat.

RK: Dus in vaste combinaties concepten/producten herhaaldelijk inzetten?

VP: Het zal moeten.

RK: Een van de bedreigingen/kansen die naar voren kwam in de enquête was de krimpende markt aan opdrachtgeverszijde en de groeiende markt aan opdrachtnemerszijde. Biedt de opdrachtgeverskant of juist de opdrachtnemerskant de grootste kansen voor DHV in de toekomst?

VP: DHV kiest bewust voor opdrachtgever én opdrachtnemer. Werken met opdrachtnemers is een leerproces dat nu gaande is om later te kunnen omschakelen. Het echte krimpen van de opdrachtgeversmarkt verwacht ik pas op langere termijn (>10 jaar).

RK: Is er in de toekomst een noodzaak om te kiezen tussen een van de twee kanten?

VP: In de nabije toekomst blijft de opdrachtgeverskant het belangrijkst. Zo moeten we bijvoorbeeld meer samendendenkend met rijkswaterstaat problemen aanpakken. In de toekomst zullen dat beide kanten worden.

RK: Innovatie en ondernemerschap zullen erg belangrijk worden in een aanbod gestuurde bouwsector. Er zijn verschillende opties mogelijk omtrent het commercialiseren van innovaties. Tijdens de ‘innovation fair’ intern bij DHV bleek dat DHV een aantal interessante concepten/ideeën heeft. Toch lijkt het innovatiebeleid van DHV erg zoekende (decentraal georganiseerd). Er zijn proactieve ontwikkelingen met betrekking tot ‘ecovilla’. Er is een prijs gewonnen met ‘Nereda’. En DHV werkt samen met BAM in de joint venture ‘schoolcompagnie’. DHV lijkt eigenlijk van alles wat te doen, maar moet er niet een meer integrale visie komen op de richting van het bedrijf en meer portfolio management?

VP: Innovatie is per definitie een bottom-up proces dat decentraal is en gestimuleerd moet worden. Het moet wel van bovenaf gestuurd en gebundeld worden en dat gebeurt onvoldoende.

RK: DHV lijkt nu nog erg veel responsief capaciteit te leveren in plaats van het proactief bedenken van oplossingen. Moet DHV niet een proactieve concept/productontwikkelaar worden?

VP: DHV moet output-based gaan denken in plaats van input-based. DHV moet meedenken met de klanten.

RK: Dus verder kijken dan de vraag waar de klant/opdrachtgever mee komt, maar proactief naar maatschappelijke problemen kijken?

VP: Juist, het heeft bijvoorbeeld geen zin om een prachtige nieuwe brug te bedenken in Zuid Afrika. Daar zouden oplossingen bedacht moeten worden om armoede en criminaliteit te voorkomen/op te lossen.

RK: Gezien het onderstaande figuur F-2. Vindt u de huidige positionering juist, zijnde breed geïntegreerd (kennis in meerdere projectfasen/functies), en moet DHV meer richting innovatief ondernemerschap?

VP: Ik ben het eens met de huidige positionering in dit schema en denk inderdaad dat DHV meer naar het kwadrant rechtsboven moet. DHV moet meer output gericht (resultaatsverplichtingen) worden maar dit is moeilijk. Dit betekent ook meer ondernemend worden en dus ook meer ondernemend personeel inzetten. Dit zou kunnen leiden tot een nieuw business model en een nieuw bedrijfsonderdeel dat buiten de huidige gezet moet worden.
A supply-driven construction industry for transportation infrastructure

VP: DHV heeft een focus op kwaliteit (‘up in the food chain’) waar minder concurrentie verwacht wordt en hogere tarieven gevraagd kunnen worden. Bij innovatie denk ik aan meer leveren voor minder geld/tijd. Je moet concept/procesmatig betere oplossingen bedenken. Neem bijvoorbeeld ‘Cyclomedia’ die met foto’s omgevingen 3D in beeld opslaan, waardoor er nieuwe toepassingsopties mogelijk zijn. Metingen hoeven niet meer uitgevoerd te worden door personeel op pad te sturen. Dit is dus meer efficiency door een beter/innovatief concept.

RK: Als er allemaal ‘Siemens’ aanbieders zouden zijn met hun eigen productfamilies en marktfocus, dan zouden opdrachtgevers misschien wel veel meer te kiezen hebben.

VP: Het gaat die kant op, maar niet volledig. Daarnaast loopt de civiele sector achter ten opzichte van de gebouwen en industriële installaties zoals kerncentrales, waar je voor specifieke systemen bij een zeer beperkt aantal leveranciers terecht kan. Het Franse bouwbedrijf ‘Bouygues’ beweegt inderdaad de aanbodgestuurde kant op. Ik heb mijn twijfels of er een behoefte is aan een partij die een centrale proactieve positie heeft en in staat is met één gebied, maar zet deze kennis gefragmenteerd, ad-hoc/projectmatig en als capaciteits-bijvoorbeeld ‘Cyclomedia’ die met foto’s omgevingen 3D in beeld opslaan, waardoor er nieuwe marktfocus, dan zouden opdrachtgevers misschien wel veel meer te kiezen hebben.

RK: De overheid treedt terug en van Rijkswaterstaat zal in de toekomst louter een professionele infra manager overblijven die totaaloplossingen wil inkopen. Daarbij is er de wens om met één verantwoordelijke partij/consortium zaken te doen die ook eindverantwoordelijk is. Gezien de toenemende complexiteit van civiele werken zal er steeds meer behoefte zijn aan een partij die het overzicht heeft (door brede kennis en ervaring) en een proactieve regisserende rol kan vervullen. In het schema is deze rol positie 3, een intermediair of integrator.

Op dit moment is DHV sterk op positie 1. DHV heeft veel kennis en ervaring op een breed gebied, maar zet deze kennis gefragmenteerd, ad-hoc/projectmatig en als capaciteits-leverancier in.

Zou DHV minder de markt moeten volgen (outside-in / responsief) omdat er toenemend behoefte is aan een partij die een centrale proactieve positie heeft en in staat is (maatschappelijke) problemen te koppelen aan de juiste oplossingen (inside-out / proactief)?

VP: DHV als spin in het web past goed bij DHV. DHV heeft een brede kennis en ervaring maar zet het onvoldoende proactief in. Op dit moment lijkt DHV al veel op positie 3, want DHV is goed
gepositioneerd als procesmanager aan opdrachtgeverskant. DHV komt echter te kort aan commerciële ervaring/kennis.

RK: De meest opvallende resultaten uit de management enquête zijn dat:
- De meeste organisatie verandering wordt verwacht voor positie 4, zijnde integrale concept/product ontwikkelaar, partner in consortia.
- De meest winstgevende positie is naar verwachting positie 3, zijnde clients’ intermediary.
- De meest gewenste positie is positie 3, zijnde clients’ intermediary (52%).

![Bar chart of the average desirability per position for DHV](image)

**Figure F-3:** Bar chart of the average desirability per position for DHV on a scale from 1 to 5.

RK: Wat verder opvalt is DHV managers aangeven dat positie 1 naast posities 3 en 4 wel gewenst is, maar men kiest uiteindelijk voornamelijk voor posities 3 en 4.

![Bar chart of the most preferred position for DHV](image)

**Figure F-4:** Bar chart of the percentages of respondents choosing for one position.

RK: Denkt u dat men kiest voor posities 3 en 4 vanwege de goede marktkansen/vooruitzichten van posities 3 en 4 of meer vanwege de slechte marktkansen/vooruitzichten van posities 1 en 2?

VP: Dat men kiest voor positie 3 komt misschien omdat DHV al veel werkt als procesmanager aan opdrachtgeverskant. Dit is echter niet proactief genoeg. Men heeft verder waarschijnlijk de perceptie dat de markt richting posities 3 en 4 gaat.
A supply-driven construction industry for transportation infrastructure

RK: DHV-managers geven in de enquête aan dat ze verwachten dat posities 3 en 4 het meest winstgevend zullen worden. Denkt u dat DHV duidelijker moet gaan kiezen voor een bepaalde positie met een bijbehorend profiel en imago?

VP: Om die winst te kunnen behalen vergt veel inspanning. De 3e positie lijkt dichterbij dan de 4e positie. Maar de grote behoefte aan technische kunde is ook positief voor DHV. Mocht het nodig zijn dan kan DHV meebewegen bij de ontwikkelingen, want aannemers zijn nog erg afhankelijk van advies- en ingenieursbureaus.

RK: Is het dan een bedreiging dat aannemers dit gat gaan vullen door zelf ingenieursbureaus op te richten of ingenieursbureaus over te nemen zoals dat in sommige landen al is gebeurd?

VP: Voorlopig denken aannemers nog erg in techniek en uitvoering en zijn advies- en ingenieursbureaus veel conceptueel. Deze afhankelijkheid biedt voldoende kansen en mogelijkheden voor DHV.

![Desirability of possible positions in a supply-driven industry]

Figure F-5: Bar chart of the percentages of agreement regarding the desirability for all positions.

RK: Bij positie 2 is te zien dat er verdeeldheid is binnen DHV. Een groep ziet positie 2 wel zitten, een andere groep ziet positie 2 niet zitten (zie grafiek). Waar zou dit op kunnen wijzen?

VP: Ik kan dit conflict bevestigen (in het algemeen). Er is een deel ‘old school’ en een deel ‘new school’. Een (behoudend) deel ziet geen toekomst in de aannemerszijde en een (vooruitstrevend) deel wel.

Verder gaf Vic Prins ten aanzien van de SWOT analyses aan dat het inderdaad een gevaar voor DHV is dat het erg afhankelijk wordt van enkele grote (publieke) opdrachtgevers zoals Rijkswaterstaat in verband met raamcontracten voor ingenieursdiensten.

Vic Prins gaf ook aan dat Rijkswaterstaat DHV te weinig proactief vindt, maar hij zag ook een barrière ten aanzien pro-activiteit in de zin dat deze rollen traditioneel zijn weggelegd voor bepaalde spelers als kennisinstituten (TNO) of universiteiten. Toch zal DHV een meer proactieve rol moeten oppakken.

Ook gaf hij aan dat om beter aan te sluiten bij de efficiency focus van aannemers, het Global Engineering Center (GEC) in India inderdaad een sterk punt kan worden. Met name bij DHV Den Haag wordt GEC steeds meer ingezet.
Appendix G: Glossary

- **Brief**
  Project definition phase, program definition or ‘List of Requirements’. Based on the orientation and feasibility of the system, in this stage the need-to-haves (mandatory) and nice-to-haves (preferences) are made explicit. The list of requirements (LoR) is used in order to develop concepts that confirm the wishes, desires and requirements of the client as much as possible.

- **Client, owner, employer or principal**
  Different terminology is often used for the same purpose. In this report the term ‘client’ is used for the value demanding party who pays ‘money for value’ and receives ‘value for money’.

- **Consulting engineer**
  Consulting engineers can be architects, design engineers, specialist consults or (management) consultants.

- **DB+**
  Design-Build and in addition possibly ‘Finance’, ‘Maintenance’ and ‘Operation’ phases.

- **Definite design phase**
  In this stage, emphasis is put on engineering and constructability design issues, which are further decomposed on component and element level. The level of variance of estimations in this stage is +15%/-10%.

- **Demand-driven construction industry:**
  Traditionally the construction industry is demand-driven; nothing happens until the demander decides to initiate a project (concept-to-order). The demanding party (client) or a consulting engineer on behalf of the client, fully specifies the solution and controls the details. Clients specify their wishes (demand) at a high abstraction level (capacity, esthetics, luxury, preferences). Consulting engineers take care of design and engineering work, resulting in a fully specified artifact (building/construction) with drawings, specifications and standards. The specified artifact is considered to be an object with fixed quantity and quality. Contractors are invited to submit a proposal containing a working method for realization and mostly a fixed price. The contractor with the lowest fixed price gets the contract awarded for realization. Creativity is fully allocated in demand specifications instead of at the supply side. When the client specifies output specifications for compliance in advance, it is still considered demand-driven. In a demand-driven system there is very limited or no room for creativity at the market and no incentive for product development, research and development and unsolicited proposals. The solution is dictated by the client and inherent risks and costs of innovation are not rewarded in a lowest-price system.

- **Detail design phase**
  In this stage, the definite design is translated into engineering design specifications. The emphasis in this stage is on element level of the design. The level of variance in this stage is +10%/-5%.

- **Environmental Impact Assessment (EIA)**
  EIA provides the information needed to allow full consideration of environmental interests in decisions on plans and projects with significant environmental impacts. The Environmental Impact Statement (EIS) shows how the proposal will affect the environment and whether there...

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22 Programma van Eisen (PvE)
23 In Dutch: Opdrachtgever.
are alternatives with less environmental impact. In the Netherlands, EIA is compulsory by law for large projects such as the construction of railway lines, roads, housing areas, industrial installations, power stations and waste incineration plants.

In accordance with Dutch spatial planning law, large infrastructure projects have to submit to the Environmental Impact Assessment-procedure (EIA)\(^{24}\). In order to consider environmental issues on a more strategic level in earlier stages of decision-making where only rough information is available, a strategic environmental assessment (SEA)\(^{25}\) takes place in the exploration stage. The detailed information required for an EIA is more likely to become available in later stages of the planning stage. Parallel and linked to the EIA another procedure is obliged for large infrastructure projects. This is called the spatial planning decision\(^{26}\) and states on macro level spatial planning issues like what locations are planned for infrastructure, nature or agriculture etc. This national government vision will consequently be further decomposed on lower government levels (provinces and municipalities).

- **Feasibility phase**
  In the Netherlands a manual (OEI-leidraad) has been developed to assess the technological, societal and economic feasibility of large transportation infrastructure projects (OEEI, 2000). In the exploration stage the (pre)feasibility of the project is being assessed based on rough (economic and social) figures. Estimations are made on revenues, costs in time, quantitative risks, realization and maintenance issues. The level of variance in this stage is +40%/-25%. The feasibility stage will conclude with a go/no-go decision about the feasibility in order start with the planning stage.

- **LBC**
  The ‘Living Building Concept’. A revolutionary vision on the construction industry.

- **Orientation phase**
  Projects (concept, design or built facility) are initiated because the public client feels a need to satisfy the wishes and desires of the public. The project starts with an orientation phase where the ‘why’, ‘who’, ‘what’ and ‘when’ are being investigated. This exploration of the usefulness and necessity of the project also takes possible directions of solutions and rough cost estimations into consideration. In the orientation phase there will also be looked at past reference projects. The definition of the problem and goals of the project, results in a goal-statement on macro-level. In the orientation stage the level of variance of estimated costs\(^{27}\) is +/-40% (De Ridder, 2006a). The goal statement is often visualized in term of an ‘artist impression’ to show how the system could look like.

- **PPP**
  Public private partnerships

- **Preliminary design phase**
  In this stage the functions of the system are translated into form like materials, structure, dimensions etc. The preliminary design often results in a master plan including several independent alternatives. Consequently, the value – cost ratios lead to the ranking of the alternatives. The level of variance of estimations in this stage is +25%/-15%.

- **Rijkswaterstaat**
  Government agency for transport, public works and water management.

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\(^{24}\) In Dutch: Tracé / Milieu Effect Rapportage (MER)

\(^{25}\) In Dutch: plan-MER / strategische milieubeoordeling (SMB)

\(^{26}\) In Dutch: Structuurvisie / Planologische KernBeslissing (PKB)

\(^{27}\) The levels of variance of estimations that are stated are indicative since budget overruns are frequently observed in reality during realization stages.
Supply-driven construction industry

In a supply-driven construction industry, the supplying party specifies its own solution, making trade-offs and purposefully limits what he offers (design-to-order/make-to-order). Components of the supplying party are fully pre-designed, specified and validated. The supplier only has to demonstrate that the aggregation of components forms the right product/service according to the client’s wishes and requirements. The demanding party (client) states its requirements and wishes on a high level of abstraction and recognizes that the supplier has the competence to define the appropriate specifications for the problem (wishes and requirements). In the supply-driven construction industry, there is room for concept/product development and unsolicited proposals initiated by supplying parties.