How value based goal modeling can help to improve collaborations in subsidiary networks a case study on CNG Net

Tigchelaar, G.

Award date:
2012

Eindhoven, March 2012

How value based goal modeling can help to improve collaborations in subsidiary networks: A case study on CNG Net

by
Gerben Tigchelaar

Student identity number 0667338

in partial fulfilment of the requirements for the degree of

Master of Science
in Innovation Management

Supervisors:
dr. ir. H. Eshuis, TU/e, IS
Prof. dr. G.M. Duijsters, TU/e, ITEM

TUE School of Industrial Engineering.
Series Master Theses Innovation Management

Subject headings: Innovation ; case studies, Value analysis, Business efficiency

Summary

Nowadays, many large companies are built as networks of small specialist subsidiaries. This way they harvest both the advantages of small companies regarding radical innovation capability, whilst using the size of the large corporation to create economies of scale. To enhance their innovation capabilities the specialist subsidiaries should work together closely in order to obtain optimal results.

Unfortunately, in many cases, these subsidiaries pursue their own interests and goals rather than the goals of the network they're working in and therefore the goals of their parent company.

This research analyses the collaborations within these types of subsidiary networks, using a modeling technique called value based goal modeling. Value based goal modeling combines two other techniques: Value based modeling, and goal requirements modeling. Value based modeling aims at the value exchanges between different actors and assesses the profitability of constellations between these actors over time. Goal requirements modeling looks at the goals of the different actors and any possible conflicts between these goals or conflicts that are due to the structure of the obtained goal model.

In literature so far, value based modeling and goal modeling are described in a top down approach, were in the end of the modeling process actors are assigned to the models. In the subsidiary networks mentioned above, the actors are already known, implying that a bottom up approach may be more appropriate for modeling these networks. This thesis project looks at the usefulness of a bottom up approach of value based goal modeling for investigating collaborations in these types of networks. The research question of this project is:

"How can Value Based Goal Modeling be used in a bottom up approach to optimize collaboration in subsidiary networks?"

This study is based on a case study at CNG Net, a subsidiary company of Ballast Nedam, one of the main Dutch construction companies.

During this research, value and goal models were constructed for the business network around CNG Net, using a bottom up approach. These models were based on information gathered from interviews with the network partners. Meanwhile, a value based goal model was constructed to reflect the way the subsidiaries in the network were intended to cooperate, according to a supervisor of the entire network. After the models were constructed, they were verified in feedback sessions with the network partners and the supervising party. Next, the network models were analyzed for possible conflicts, operational problems and possible solutions and compared to the models based upon the input from the supervising party. These last models thereby served as a reference model of how the network was intended to work, so that possible improvements would not be a redesign of the network as originally intended.

From the modeling process in the CNG Net case it became clear that, for this case, the bottom up modeling processes could not be seen as a direct inversion of the top down processes. Some steps in the value based modeling process were found to be executed simultaneously during the bottom up approach, while these were consecutive in the top down approach. In goal requirements modeling the determination of the main goal(s) should be the final step according to a direct inversion of the top down approach, but was found to be very useful to determine in the beginning of the modeling process.

After analyzing the models and drawing up scenarios for improvement for the CNG Net case, this analysis and scenarios were validated during a workshop session with the network partners.

It was found that value based goal modeling can definitely serve as a good way to illustrate subsidiary networks and the collaborations within these networks and serve as a helpful tool to analyze any problems. Nevertheless, this research has been based upon only one case study. This means that all research and conclusions in this thesis were only validated by this single case study.

Table of contents

List of figures

List of tables

1. Introduction

Since the industrial revolution during the 19th century, companies have been growing to sizes never seen before. While in earlier times companies existed as just one large entity, as these companies grew larger, they became harder to manage and rather inert. As management problems increased, many of them structured themselves as a group of small subsidiary ventures. In this way, these large and inert companies could be split into smaller and easier manageable blocks. Since these subsidiary ventures often have their own specialities, the parent company is sometimes actually made up of a very large number of specialists. Dividing the company up into specialist subsidiaries results in the advantage of flexibility and ability for radical innovation related to small companies. Meanwhile by being placed under the same large parent company, the subsidiaries harvest the advantages of economies of scale (Hisrich & Peters, 1986). These subsidiaries do not only work solely for customers, but often collaborate to deliver the parent company's products.

Combining their specialties enables the parent company to easily integrate competences and the highest innovational technologies present at these small subsidiaries. They can keep the company manageable, but still posses and use many skills, technologies and patents, without extremely high expenses made to other companies for outsourcing development or use of patents.

Unfortunately, although these subsidiaries work for the same parent company and thus, should work towards the same common goal, collaborations between them are often far from effective. Competition between different entities and differences in their perceived goals make that subsidiaries often work against each other for their own benefits instead of effectively cooperating to reach the parent company's optimal benefits. When the corporation is divided into small subsidiaries to optimize innovation, these subsidiaries will have to work together in the best possible way.

In this thesis project I will explore this kind of collaborations, using two different modeling techniques: Value based modeling and goal requirements modeling.
Value based modeling focuses on the value exchange between different entities or so called actors (Gordijn, 2002) (Gordijn & Akkermans, 2003) and relies on the assumption that enterprises are profit and loss responsible entities that will only participate in a value constellation when they have a reasonable chance of making profits (Gordijn et al. 2006). It intends to explore innovative business ideas with the aim to understand such an idea throuroughly and to evaluate it for potential profitability.

While value based modeling illustrates the economic sustainability (i.e. the profitability over time) of constellations, goal requirements modeling can explain reasons for this sustainability or its absence through illustration of goal conflicts or enhancements. Goal requirements modeling originates from information systems engineering and entails that one works towards a requirements analysis from the main goal(s) of an information system (Gordijn et al. 2006) (van Lamsweerde, 2001). Beside requirements analysis, goal modeling also illustrates conflicting or reinforcing goals (Dardenne et al., 1993) (Van Lamsweerde, 2001).

The hypothesis of this thesis is that through value based goal modeling of subsidiary networks, one can illustrate and analyze any conflicts or problems between actors within the network, find solutions to these problems and test them through simulating the (new) value model.

This master thesis research evolves around a case study on CNG Net. CNG Net works together with other Ballast Nedam subsidiaries to exploit CNG stations for transportation purposes.

1.1 The CNG Net case

This research is based upon a case study around the Dutch company CNG Net. CNG Net is a subsidiary of Ballast Nedam, one of the main Dutch construction companies. CNG Net's main goal is to sell as much gas as possible in a profitable way. In its business case, CNG Net works together with two other Ballast Nedam subsidiaries: The contractor and The management partner. The contractor fulfills two roles in this value constellation, making enabling it to be divided up into two actors, which results in the following four actors in the network:

CNG Net: As a subsidiary of Ballast Nedam Consessies, CNG Net exploits CNG filling stations for road vehicles. They judge locations in terms of expected revenue and market potential. When they find a suitable one, they invest in a pumping installation (consisting of a compressor, buffer and pump). The management of this station is then transferred to The management partner. CNG Nets primary activity is to sell as much gas as possible, while making the highest possible profits. Therefore stations should not only sell as much gas as possible, but above all should have a high return on investment. In their business model, CNG Net sells gas through existing petrol stations, paying a small fee per kg sold gas to the owner of the station in return for providing facilities and also paying a fee per kg of sold gas to The management partner for management and maintenance. CNG Net is also responsible for market development through for instance transport concessions.

The contractor (Design & construction): The contractor is a specialized subsidiary of Ballast Nedam. One of their specialties is the construction and maintenance of fuel stations. CNG is a new, upcoming market in The Netherlands and therefore rather new for The contractor as well. Regarding the fact that there is little need for new petrol stations, building CNG stations is a new business opportunity to ensure future business for IPM. In the CNG Net case, the design and construction department of IPM selects potential locations for CNG stations since they have more contacts within the fuel market than any of the other actors in the network. CNG Net purchases the stations at IPM.

The management partner: The management partner is a specialized subsidiary of Ballast Nedam in asset management. They manage all kinds of assets, like buildings, highways, wind turbines and petrol stations. The management partner monitors, controls and collects and manages data on the assets. In the CNG Net case, CNG Net transfers their CNG installations to The management partner to manage them. The management partner in their turn receives a fee per kg sold gas, which they partly use to outsource maintenance to The contractor.

The contractor (Maintenance): This subsidiary of The contractor is specialized in maintenance of the objects built by the design and construction department. In the CNG Net case, maintenance of the CNG installations is outsourced to IPM by The management partner.

In practice, this means that CNG Net invests in a CNG filling station and places an order at The contractor to build the station. CNG Net then hands the station to The management partner to manage it, which in their turn outsources the maintenance back to The contractor.

Unfortunately, despite the fact that these businesses are all subsidiaries of the same parent company (Ballast Nedam N.V), the cooperation between them is far from efficient. All four actors perceive that there is much room for improvement in the way they work together. The large amount of arguments and lack of trust between them lead to frustrations and dissatisfaction about the results from their cooperation. Although there is a will to increase efficiency, the four involved actors experience that there is still a lot of room for improvement.

The four partners are frustrated about the way they work together, their responsibilities and the transparency between them. The research on this case study will focus on the collaboration between these partners and how to identify conflicts and obstacles in the network and suggest improvements, using value-based goal modeling.

1.2 Research question

The original value based goal modeling method, uses a top down approach. The goal requirements modeling part starts by determining the main network goal(s), working down to sub goals and finally operational goals or so called requirements, that can be directly assigned to actors (van Lamsweerde, 2001) (Dardenne, et al., 1993). The value based modeling part starts with a global value model, working towards more detail, after which a dependency path is added, illustrating the sequence of value exchanges in the network. Finally, the appropriate actors are found and assigned to the value model and to the operational requirements in the goal model.

In this case of the subsidiary networks under discussion, the actors are already known. This means that the ultimate goal of the modeling process is not to identify the actors and assign them to the network, but model the main goal(s) and economic sustainability and to optimize the means to reach them in the network as it is. A bottom up approach seems

more appropriate than a top down approach. Literature so far mentions the top down, but not the bottom up approach (van Lamsweerde, 2001) (Dardenne, et al., 1993) (Gordijn, et al., 2006) (Gordijn J. , 2002).

The research question of this master thesis project will therefore be:

"How can Value Based Goal Modeling be used in a bottom up approach to optimize collaboration in subsidiary networks?"

This is an explorative research project and the outcome is expected to explain how Value Based Goal Modeling can be used to analyze, explain and improve collaborations within subsidiary networks and on the other hand to what extent it can be used to do so.
To answer the research question, we can distinguish three sub questions:

1. How can we design a value based goal model from the actors and their specific goals, bottom up to the main network goal, using the characteristics of the network at stake?
2. How can we design a value based goal model from the dependency path of a network, bottom up to the network's value model, using the characteristics of the network at stake?
3. How can we convert a value based goal model of the network at stake as it is into a more optimal situation, by analyzing conflicts and providing scenarios for improvement?

The third sub question relates to a situation based upon the model of the current network situation and a reference model. This reference model is derived from information from a party supervising the network, on how it was originally initiated. It serves to prevent the result from being the same as the initiated network and may also serve to provide means for improvements of the current network. The three sub questions are shown by numbers in the bold black arrows in the schematic illustration of the bottom up approach in Figure 1.

The schematic in Figure 1 is based upon the inversion of the top down modeling processes of goal requirements modeling as described by Van Lamsweerde (2001) and Dardenne et al. (1993) and value based modeling as described by Gordijn (2002) and Gordijn et al. (2006).

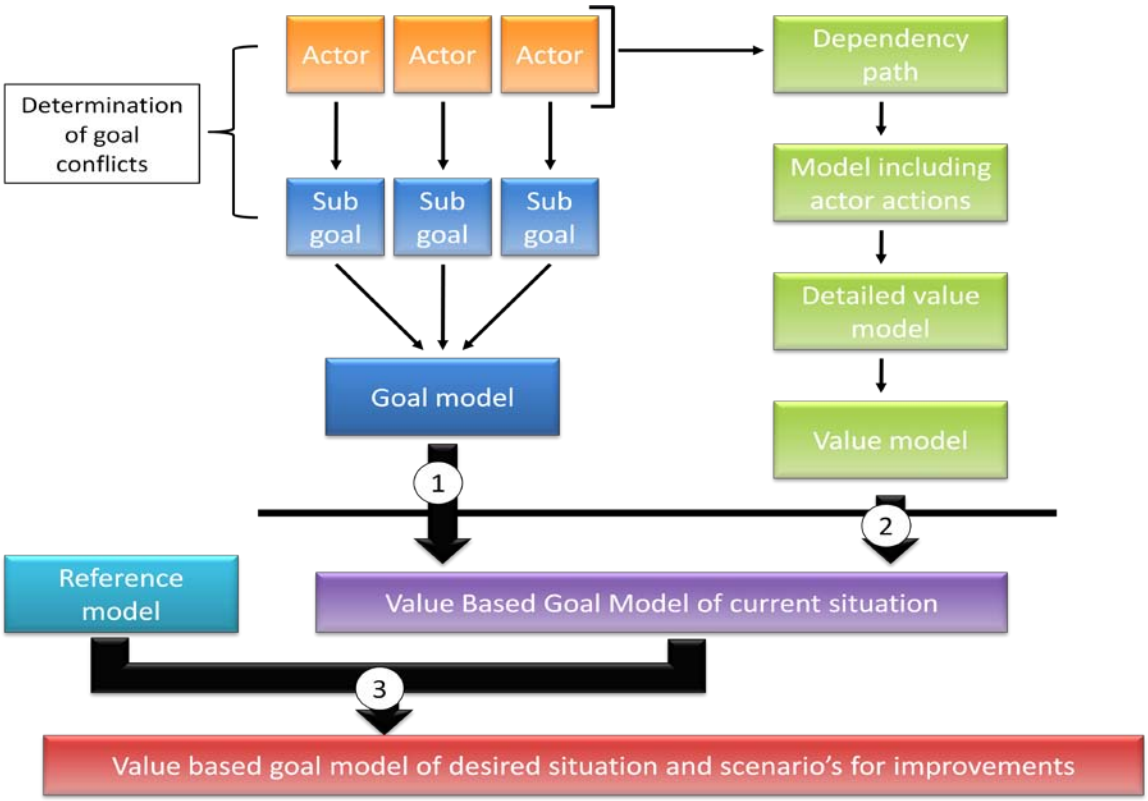


Figure 1 - Bottom up approach for Value Based Goal Modeling

1.3 Methodology

To answer the main research question, a case study was conducted at CNG Net, a subsidiary of a major Dutch construction company, Ballast Nedam. For this business case, CNG Net needs to work together with several other Ballast Nedam subsidiaries.
The main research question was to be answered through the three sub questions in chapter 1.1, implying several steps in the case study.

The first step was to find a way to build value and goal models from a bottom up approach, starting from the actors and working up to the total models. Therefore, the first thing to do was to investigate what information is needed to construct these models and to gather that information from the network through interviews in an iterating process. The iterations will emerge from the fact that not all the correct data could be collected from the interviews due to biases from respondents, differences in interpretation between the interviewer and respondent (Blumberg, et al., 2008) and emergence of new questions during interviews with other network partners.

The second step was to see how these two models, the obtained goal model and the value model, can be linked and eventually be combined to supplement each other. Gordijn et al. (2006) already suggest several ways in a top down modeling approach where they examine the results from simulations of the value model and they feed these results back into the goal model. They then adjust the value constellation under examination and

simulated it again. After analyzing the models, I investigated to what extent these methods are useful in the bottom up approach and what other possibilities there are to combine the models and to come closer to answering the main research question of this thesis project.

Finally, to answer the third sub question, the value based goal model of the current network situation was compared to the reference model as explained in chapter 1.2. By analyzing the model of the current situation in terms of possible conflicts, comparing it to the reference model and by simulating the value models, scenarios for improvement can be suggested.

To construct the models, there was a need for data collection on the network. I did so by interviewing the network partners. These interviews were to provide information on value exchanges, network and actor goals and the relationships between actors. For the CNG Net case study I chose to use two rounds of interviews with the network partners: A first round of orientation interviews and a second round of more thorough interviews. The first round of interviews enabled me to formulate more detailed questions for the second round of interviews, allowing to get further to the bottom of the problems at hand. The interviews were held with the network partners separately, to avoid bias due to the presence of other partners (Blumberg, et al., 2008).

1.4 Thesis outline

I will start this thesis with a short introduction and background on Value Based Goal modeling in chapter 2. After that, I will continue with a description of the bottom up value based modeling and goal requirements modeling processes with regard to the CNG Net case study in chapter 3 and 4. In these chapters, I will also elaborate as much as possible on general issues regarding the bottom up approach. Chapter five comprises the linking of the goal model and value model into a value based goal model.

After describing the modeling process of network in the CNG Net case, I will go into detail on the reference model and analysis of conflicts and problems, followed by possible scenarios for improvement. Finally, the validation and conclusions and recommendations of this research will be discussed in respectively chapter 7 and 8.

2. Background

As described in the introduction, I will look into the collaborations within subsidiary networks using value based goal modeling. This modeling technique comprises of two separate techniques that find origin in information systems: Value based modeling and Goal requirements modeling.

Looking at inter-organizational cooperation and alignment, it seems rather obvious to look at the value exchange between the different stakeholders. This statement relies on the assumption that businesses are always profit oriented and therefore, work together in order to make and/or increase these profits (Gordijn J. , 2002). Besides the value exchange, the goals of the independent actors are of interest, since they will provide insight to the directions of the actors' actions. To see if different partners work together in an optimal way, it is interesting to see if they share the same business goals or maybe pursue conflicting goals. These two aspects can be visualized through value-based modeling and goal requirements modeling.

The research in this thesis project is based on a common goal requirements modeling technique, called KAOS (van Lamsweerde, 2001) (Dardenne, et al., 1993), combined with E^3-value modeling (Gordijn J. , 2002) (Gordijn & Akkermans, 2003).

2.1 Value based modeling

Stakeholders in a business network exchange objects of value. The most common of course being money, but there are countless other objects of value that can be exchanged between business partners. Examples are raw materials, finished products or services. Value based modeling provides a means to illustrate these exchanges and examine their economic sustainability. In a top down approach, exchanges between actors are pointed out, their actions in the value constellation are then derived and assigned to them and a dependency path of the exchanges is drawn up. This dependency path shows the sequence in which the exchanges take place over time between the different actors. By simulating the value based model, one can test its economic sustainability, but not the reasons behind this sustainability or the absence of it.

In value modeling, we can distinguish the following concepts (Gordijn J. , 2002) (Gordijn & Akkermans, 2003):

Actors:	An economically independent entity as perceived by its environment.
Actor action:	The action an actor undertakes in the value exchange or constellation.
Value objects:	An object exchanged by actors, which is of value to one or more actors.
Value port:	Used to interconnect actors in order to enable them to exchange value objects. Objects flowing from one actor to another denote a change of ownership and or rights. The value port is used by the actors to show that it wants to provide or requests value objects.

Value offering: The value offering shows what an actor requests from or offers to its environment and is a number of equally directed value ports offering value objects. It also implies that all ports in that offering should exchange value objects or none at all. Value offerings come in when (1) actors request value objects only in combination with other value objects or (2) actors only offer value objects in combination with other value objects.

Value interface: Actors can have one or more value interfaces, which, in its simplest form consist of one value offering, or in other cases one in-going and one out-going value offering between different actors.

Value exchange: A value exchange is used to connect two value ports and represents one or more potential trades of value objects. The value exchange shows which actors are willing to exchange value objects. One value port can be connected to multiple value exchanges, enabling the value port to exchange value objects with either one of the connected actors.

Value transaction: The value transaction aggregates all value exchanges that define the value exchange and is actually a bundle of value exchanges. This transaction can be between two actors or multiple actors (multi-party transaction).

Market segment: A set of actors that for one of more of their value interfaces share the same valuation of value objects from an economic perspective. These actors are modeled explicitly as one entity. Though, when an actor holds value interfaces different than those of the other actors in the market segment, this actor should be modeled explicitly.

Dependency path: Or scenario path, consists of one or more segments, related by connection elements, start and stop stimuli, and responsibility points. A path indicates via which value interfaces objects of value must be exchanged, as a result of a start stimulus, or as result of exchanges via other value interfaces.

An example is given in Figure 2 where the interaction between a publisher, a bookstore and its customers is modeled. The bookstore buys books from the publisher, after which customers will come to the bookstore and buy books. The figure shows several of the concepts described above and shows a dependency path with a start stimulus at the publisher (the red circle with the black circle around it) and a stop stimulus at the customers (the red circle). There can be AND and OR splits in the dependency path, in case all of the multiple actors are involved in a succeeding step of the exchange or at least one of several.

2.2 Goal requirements modeling

To investigate collaborations within a business network, we can also consider the different goals of the actors within the network. Through goal requirements modeling, we can model the main goals of different actors and the sub goals the actor wishes to achieve to get to their main goals, as well as the goals and sub goals of the network as a whole.

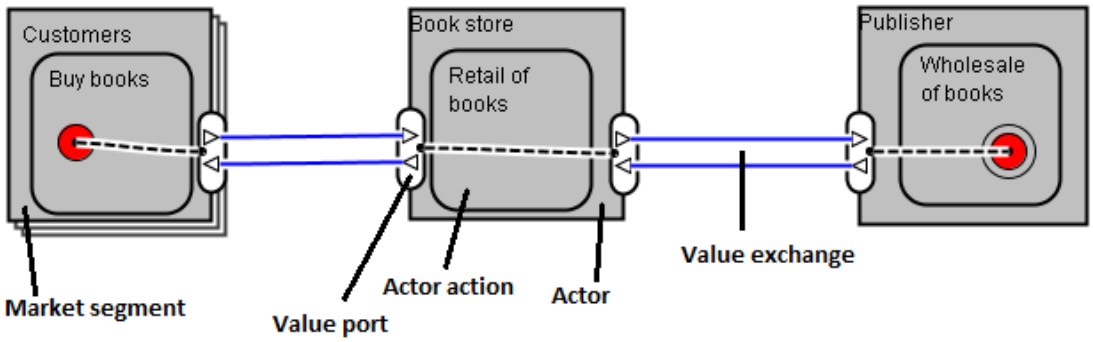


Figure 2 - Example value model

Although the obtained goal model does not show any economic sustainability of the network, it does enable the illustration of any conflicts between goals of different actors or even within actors. It may also indicate goals that enhance each other and therefore increase their effects. Although the model doesn't directly tell anything about economic sustainability, the conflicts or promotions may explain success or failure of collaborations. If two or more parties have conflicting goals within a business network, or one partner pursues conflicting goals, these goals obstruct optimal success over time. On the other hand, some goals may promote others, increasing chances of success.
In goal requirements modeling we can distinguish several concepts. The concepts relevant to this thesis can be defined as (Dardenne, Van Lamsweerde, & Fickas, 1993), (Van Lamsweerde & Letier, 1998):

Composite system:	A system comprised of agents or actors. In the case of this master thesis project, these are the different partners within a subsidiary network, so the composite system is the network formed by the subsidiary companies. In this thesis, the term actor will mainly be used.
Actor:	An actor is a type of object which performs actions over objects.
Action:	An input-output relation over objects. Actions define state transitions, characterized by pre-, post- and trigger conditions.
Goal:	A non-operational objective of the composite system.
Requirement:	An operational objective. A requirement is operational as it can be achieved by application of actions available to an actor.
Responsibility:	The assignment of achieving an operational requirement to one actor. This actor then carries the responsibility of the achievement. This is not to be confused by interest. Achievement of a goal can be in the interest of one actor, but can be the responsibility of another actor.
Conflict:	A conflict occurs when two or more goals contradict in the sense that achieving one goal counteracts the achievement of the other.
AND-refinement:	An AND-refinement links a goal to a set of sub goals or requirements, where all sub goals or requirements must be realized to achieve the main goal.

OR- refinement: An OR-refinement links a goal to a set of sub goals or requirements, where at least one sub goal or requirement must be realized to achieve the main goal.

Scenario: A scenario can be described as a composition of applications of actions by corresponding agent instances.

Goal models are constructed as tree-shaped models, with one of several main goals at the top of the model and sub goals further down, finally resulting in requirements at the bottom. AND and OR refinements can be made in cases where one goal has several sub goals or requirements. In case of an AND refinement, all sub goals or requirements need to be fulfilled to reach the goal. In case of an OR refinement, at least one of the sub goals or requirements needs to be fulfilled. Examples of AND and OR refinements and their visualization can be found in Figure 3.
In the first case, where the goal is to increase profits, there are two sub goals (increase income and decrease costs). Either one of them should be fulfilled to reach the top goal (OR refinement). In the second case, the main goal is to maximize profits, in which case both sub goals should be fulfilled (AND refinement).

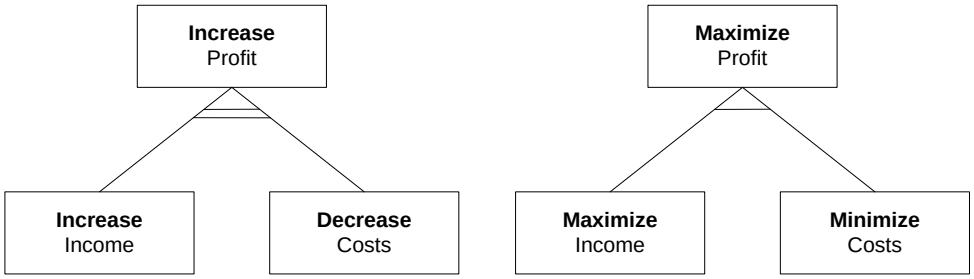


Figure 3 - Example goal model

2.3 Value based goal modeling

Gordijn et al. (2006) combined these two modeling techniques into value based goal modeling, a technique combining the advantages and possibilities of both value based modeling and goal requirements modeling.
While Value Based Goal Modeling can explain the success or failure of value constellations, as Gordijn et al. (2006) have shown, it may also be useful as an instrument to illustrate and analyse collaborations between actors in a constellation and function as a tool to incorporate improvements.

The combination of goal requirements modeling and value based modeling into value based goal modeling, results in a modeling technique that both illustrates the economic sustainability and an explanation of failure or success in accomplishing this sustainability (Gordijn, et al., 2006).
With the value based goal model as a starting point, managers can easily suggest, test and verify different network structures or value exchanges to improve economic sustainability or profitability of the network.

3. Bottom up value based modeling

So as I discussed in chapter 2, value based goal modeling is the aggregation of two separate modeling techniques: value based modeling and goal requirements modeling. According to the schematic diagram of this research in Figure 1, both modeling techniques should be approached separately and bottom up, to result into two models that are merged into one value based goal model. Starting from the actors, we can construct both models, starting in this chapter with the value based model, followed by the goal model in chapter 4.

The bottom up value based modeling process as described in this chapter consists of three main steps. The first is to gather information through interviews, the second is the actual modeling based on this information and the third step the revision of the obtained models with the actors. The first two steps will be discussed in this chapter in the context of the CNG Net case followed by a description of the more general bottom up value based modeling process.

In a top down approach, the actors themselves are not always known. The modeling starts from a global value constellation, working down towards a more detailed constellation, the actor actions and finally the dependency path (Gordijn J. , 2002) (Gordijn & Akkermans, 2003). In a bottom up approach we should therefore start with the dependency path and work upwards to the global overview (Figure 1).

3.1 Data collection in the CNG Net case

In order to construct and simulate the value model, certain information was needed about the interaction between the actors. First, to construct the model, it was required to know which parties exchange values and the order in which this was done. Also, it is important to clarify all exchanges with actors outside the network when present. Value entering or leaving the network obviously has its influence on the networks economic sustainability. The latter is also important when simulating the network, since economic sustainability is tested through simulation. To simulate the network, three other factors are important.

1. The frequency of the exchanges
2. The value of the exchanges (in currency)
3. The form of the exchanges (fixed or variable).

Through these factors, together with the sequence and structure of value exchanges, it is possible to simulate the economic performance of the network over time.

The structure and sequence of the value exchanges have been addressed in the initial interviews. From the first interviews, a global structure of the value model could be drawn up. This global structure then served as a guideline to direct the second interviews. During the second interviews, when the structure of the value constellation was largely mapped, the value and frequency of the exchanges could be addressed and further investigated. Also the global structure resulting from the first interviews was verified with all actors. The second round of interviews served as a further insight to the

first interviews, but also as an iterating process to obtain complete and correct information.

3.2 Value based modeling in the CNG Net case

In the network around CNG Net, there are four actors exchanging value with each other. These are, as aforementioned, CNG Net, The contractor (design and construction), The contractor (Maintenance) and The management partner.
With the information from the interviews, I started mapping the dependency path(s) within the network. Schematically writing down the exchanges and their sequence, using a horizontal axis as a timeline, already provided insights in the actors' roles and provided a good basis for the value model in the form of a global model. An example of such a model is provided in Figure 4. The arrows depict value exchanges. In Figure 4 there is also a distinction between AND and OR splits. This example implies that first, Actor A exchanges value with Actor B, who then exchanges with both Actors C and D. Finally, Actor D exchanges value with either Actor E or Actor F. Below the names of the actors are their actions or roles within the value constellation.

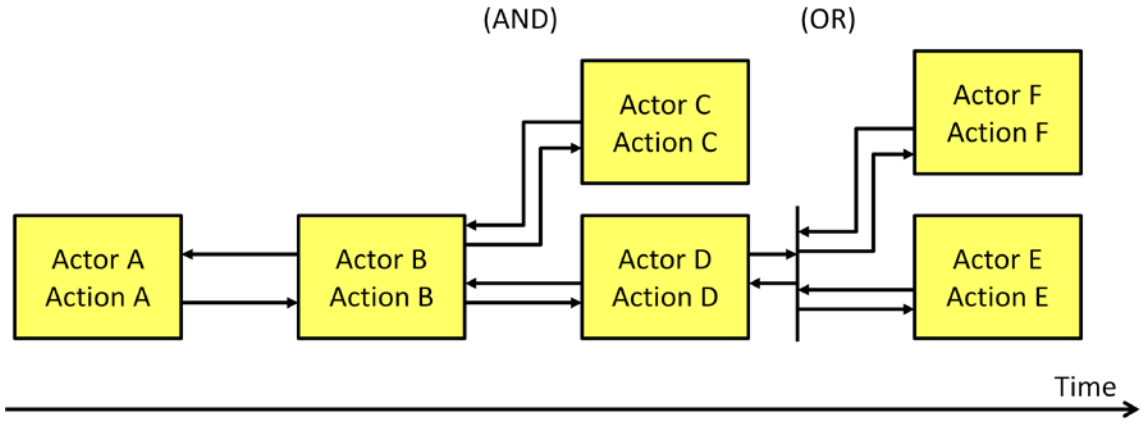


Figure 4 - Global model

From this global model, it is easy to construct a value model illustrating the entire network's value exchanges (Figure 5).

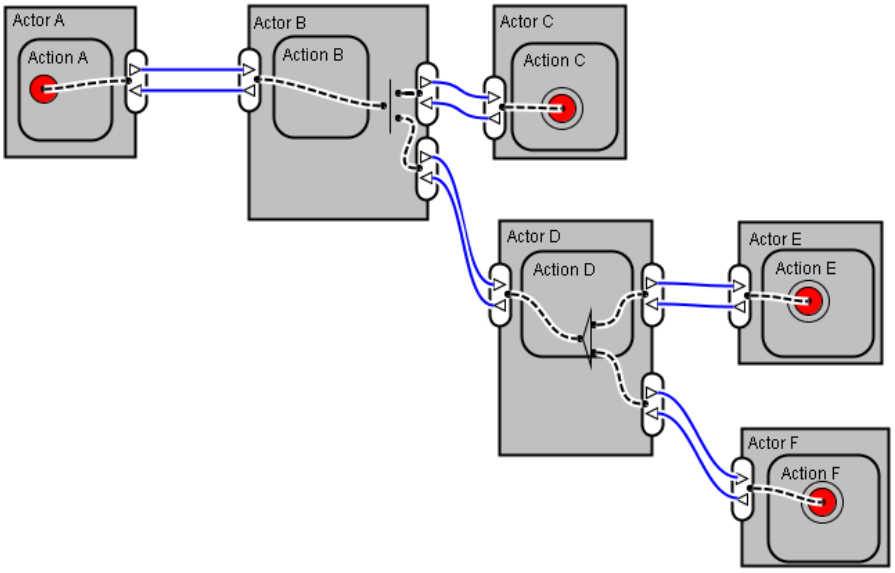


Figure 5 - Value model

The interviews showed that the actors in the CNG Net case enact with several parties outside the network. The most important are suppliers of parts for the filling stations, pump station owners, customers buying gas and gas suppliers.
There are actually two dependency paths in the business case of the network around CNG Net.

The first path describes the process of building the gas station, the second path describes the sales of gas and related operations. In the building process, the design and construction department of The contractor selects and suggests a location to CNG Net. This location is judged by CNG Net on expected profitability and suitability. When the location passes both tests, The contractor is paid a fixed fee for the location and CNG Net purchases the station. Both rewards from CNG Net to The contractor's construction department are fixed sums. CNG Net also pays a fixed fee for the connection to the gas network. In the second path, customers buy gas by filling up their vehicle. They pay for this gas per kilogram. For each kilogram of gas sold, CNG Net pays the gas suppliers, the station owner and The management partner a certain amount of money as compensation for gas, facilities and management and maintenance of the CNG installation. The management partner in its turn outsources the maintenance of the installation to The contractor, which also gets paid per kg sold gas (Figure 6).

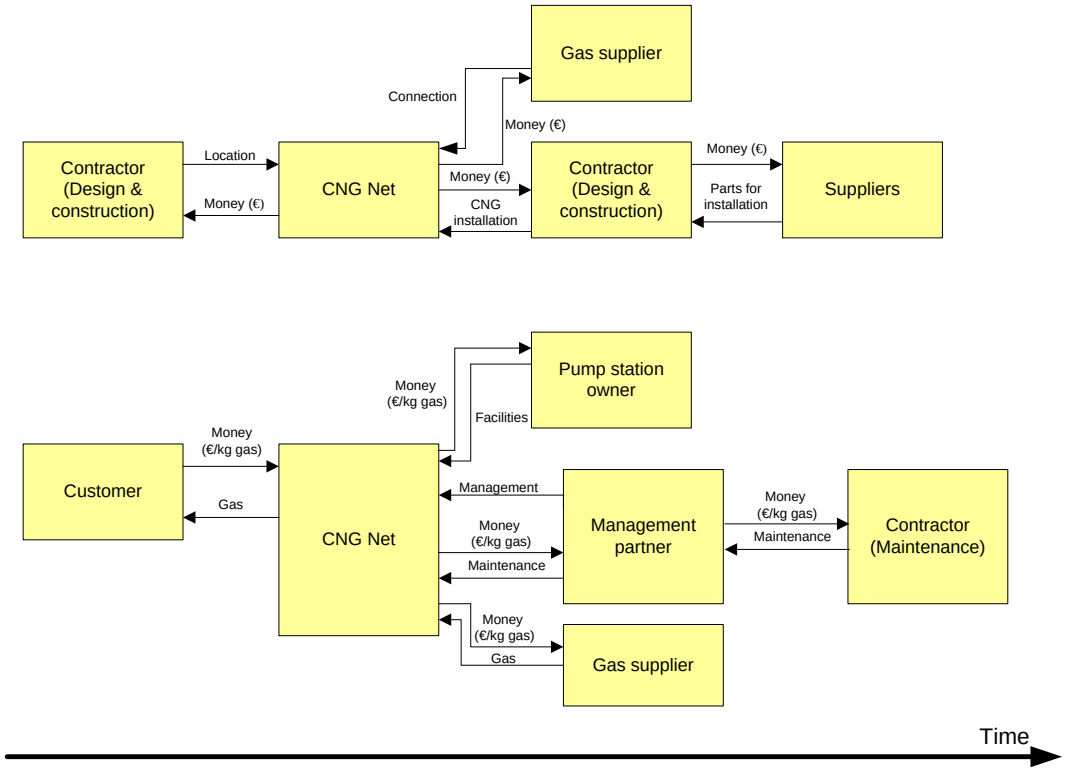


Figure 6 - Global value model in the CNG Net Case

From the above paths, the actors and the value exchanges between them, as resulted from the interviews, a value model can be build. This model shows the network partners and the way they interact in exchanging value (Figure 7).

To construct the value model information on how different actors exchange value and the order of their actions is required. The basis for this information was found in the first round of interviews, where the global exchanges within the network are mapped. The second round of interviews elaborated on the sequence and form of the exchanges, important for simulating the model.

3.2 Bottom up value based modeling in general

When putting the results of the CNG Net case in a more general sense, several issues came up.

First, during the modeling process it became clear that to know the dependency path, one should also know the actors' actions and i.e. it's rather meaningless to ask which parties exchange value, without asking why and in what way. Therefore, the determination of the dependency path and the actor's actions should occur during the same step (Figure 8).

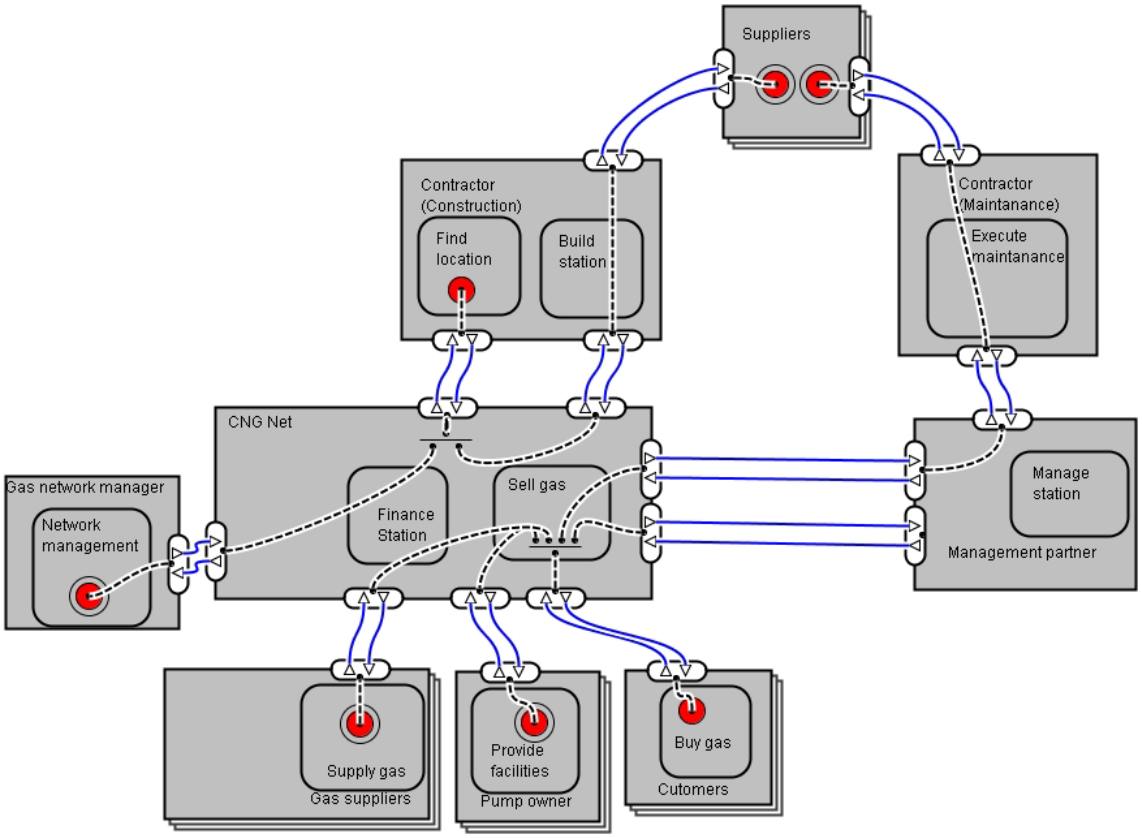


Figure 7 - Value model in the CNG Net case

Secondly, according to the schematic diagram in Figure 1, a detailed value model should be constructed first, followed by a global model. In practice, a global model will automatically follow from the information on the value exchanges, the dependency path and actor actions, which can then be further processed into a detailed model.

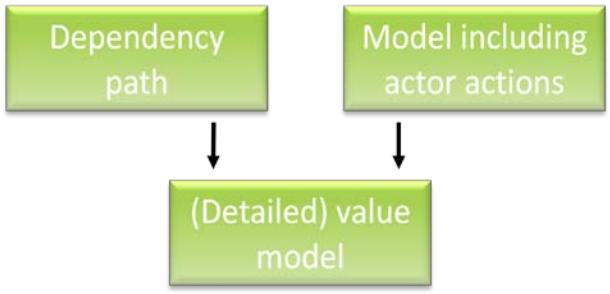


Figure 8 - Bottom up value based modeling process

4. Bottom up goal requirements modeling

As we have constructed the value model from the actors and their actions, we can from the same actors start constructing the goal model. This chapter will deal with the methods used in the CNG Net case to construct the goal model from the four actors involved in the network, concluded with some general implications for bottom up goal requirements modeling.

As in the bottom up value based modeling process, the bottom up goal requirements modeling process in the CNG Net case consists of three main steps. Again, the first was to gather information through interviews with the network actors, the second the actual modeling based on this information and the third step was the revision of the models with the actors. In this chapter, the first two steps will be discussed in the context of the CNG Net case, followed by a more general description of the bottom up goal requirements modeling process. The revision of the models will be discussed in the validation of the research (chapter 7).

4.1 Data collection in the CNG Net case

In top down goal requirements modeling, one starts with the main goal(s) and works down to sub goals and requirements and finally assigns actors to the requirements (van Lamsweerde, 2001) (Dardenne, et al., 1993).
Since in bottom up goal modeling, the actors and their actions (and operational requirements) are mostly known, it would be obvious to start with the operational requirements fulfilled by the actors and then work up to the sub goals and finally the actors' and networks main goals (Figure 1). Unfortunately, solely using operational requirements, it is not possible to obtain the (sub) goals with certainty. It is possible to guess the goals of a network partner from the operational requirements they fulfill, but you can never be certain. In other words, you cannot be certain why an actor undertakes a certain action unless you ask the actor what the goal of the action is.
For this reason, for bottom up goal requirements modeling you should not only ask the actors for their requirements, but also what the final goal is they wanted to reach. The main goal can in this case serve as a guideline for directing the interviews.

Besides, actors can only be certain about their own goals and only guess what the goals of the other actors are. Therefore, in bottom up goal modeling of a business network, it seemed most appropriate to model the separate actors and the global network (each actor can give his opinion on the goals of the entire network) and then place the actors' models into the network model.
Therefore, during the interviews, I focused on four issues:

1. What are the goals of the separate actors?
2. How do these actors plan to accomplish these goals?
3. What is the goal of the total network according to the separate actors?
4. How do the actors plan to accomplish this goal?

In the initial interviews I did not go into much detail. Just by asking each actor for its role within the network already provided an indication of the actor's goal(s). For instance,

looking at the earlier book store example, if one actor's role is to sell books, it is likely that this actor's main goal is to sell as many books as possible for a profitable price.

During the second series of interviews with the network partners, it was not only important to clarify what the (sub) goals of the partners are, but also what they think the (sub) goals of the network are. It was of the utmost importance to obtain this information through open questions without insinuating any goals or directions in the answers to eliminate bias.

4.2 Bottom up goal requirements modeling in the CNG Net case

From the information acquired through the interviews, goal models of the actors and the global network could be drawn up. Different from the interview questions that are directly focused on goals, the value model could also be used to derive goals since value creation and exchange can be linked to business goals. This will be elaborated in chapter 5 where the two models will be linked.

Through the interviews it became clear that the actors perceived that there were multiple goals for the network, like increasing gas sales and increasing building and maintenance volume. Nonetheless, these goals should, as it entails a business network, finally lead to profit making or even profit maximization. Therefore, the goal of making profit can be placed as a major goal above the goals recognized by the partners and link them together.

In the case of CNG Net, two rounds of interviews with the network partners were conducted as described above. From these interviews, four separate goal models where drawn up, one for each of the different actors (Appendix 2a) and one global network model (Appendix 2b).
Four main goals for the network emerged from the interviews that should lead to profit maximization:

1. Maximize building volume,
2. Maximize maintenance volume,
3. Maximize gas sales
4. Decrease operational costs.

Regarding the construction department of The contractor, they perceived their main goal to be maximizing profit, which could be accomplished in two ways:

1. By cost minimization
2. By maximizing the number of building assignments, as well within as outside of Ballast Nedam.

One remarkable outcome in the interview was that they state to have more incentives to reduce building costs for assignments outside of Ballast Nedam due to competition for such assignments. This cost reduction comes with higher risks, which are not taken in the CNG Net case.

The maintenance department of The contractor indicated that maximizing profit is also their main goal, but this is to be reached by increasing the number of stations to maintain and reducing the costs per kg sold gas. To reach these two goals, their interest is in the amount of gas sold, the return per station and the number of stations (better coverage of stations makes maintenance more cost efficient).

The main goal of The management partner is to deliver the best possible asset management. This is mainly done by increasing the operational availability of the assets and by decreasing the operational costs of the station. Their main activities are the administration of maintenance and operations and support in the purchasing of gas.

Finally, CNG Net also indicated that their final goal is to maximize profits through high gas sales and cost reduction. However, these high profits only appear when there are high returns per station. Besides just selling gas, CNG Net also finances the stations and is responsible for market development.

After the actors and the global overview of the network were separately modeled first, the actors' goal models could be placed within the global network model. This was done as shown in Figure 9 and Figure 10. The figures show three actors models (Actors A, B and C) and a global model of the entire network. Where the sub goals of the entire network match the main goals of actors, actors can easily be placed within the network model (Figure 10). Here, the main goals of actors A, B and C match the sub goals in the model of the network and the actors' models can be placed easily in the network model.
Another option is that for instance one actor's main goal complies with one of the other actors' sub goals, or where one actor fulfills more than one sub goal of the network model, resulting in the model of Figure 11.
What should be kept in mind using this approach is that the overall picture illustrated during the interviews is retained while combining all the separate actors' models in the network model.

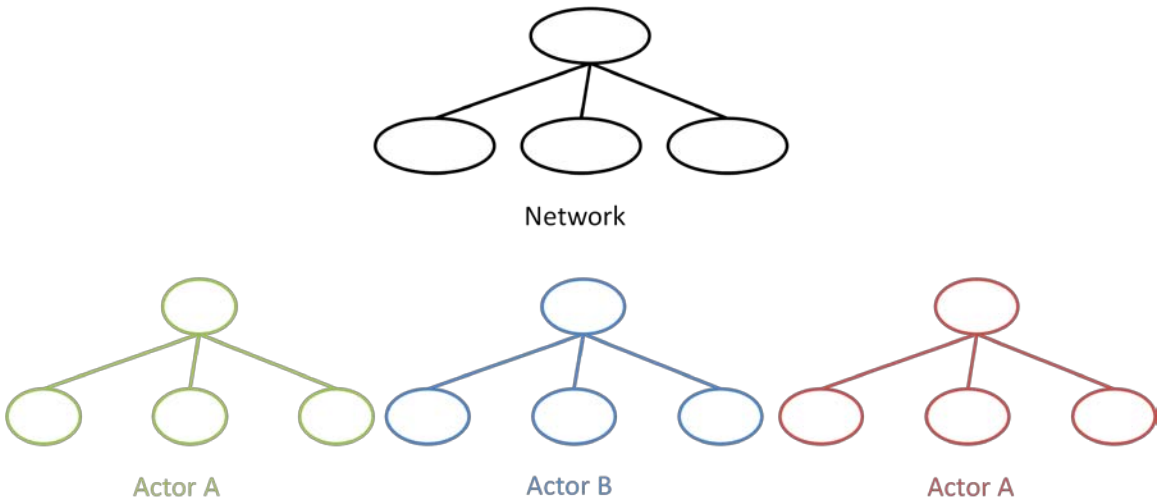


Figure 9 - Modeling a network from actors' goal models

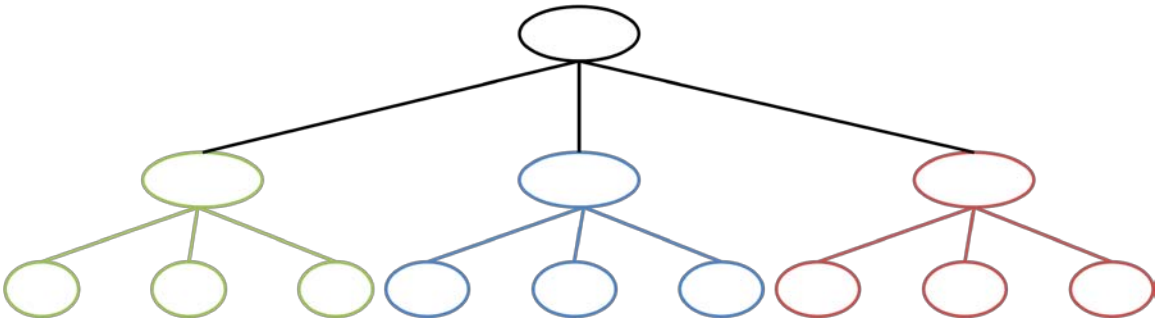


Figure 10 - Network goal model with actors assigned to sub goals

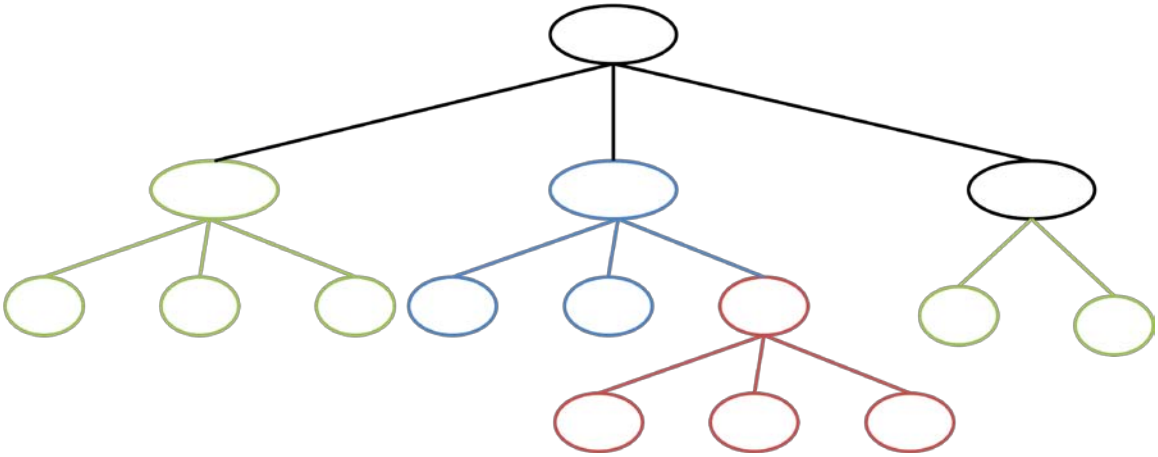


Figure 11 - Network goal model with actor fulfilling other actor's sub goal

The four models shown in Appendix 2a were merged in the network model shown in Appendix 2b, resulting in the total network model shown in Appendix 2c.

After the actors' models were inserted into the network model, it could be made visible which goals were assigned to which actors by assigning colors to goals and requirements. It became clear that there were three main issues to consider, each of which can reveal signs of operational problems within the network:

1. Goal conflicts within the network, either being between goals or requirements of different partners or goals or requirements of one partner.
2. Goals that depend on sub goals or requirements assigned to (an) other actor(s) than the goals themselves.
3. Requirements that are not assigned to any actors or assigned to multiple actors.

The first issue comprises goals that do not enhance each other, but conflict. For instance, when one goal implies cost reduction, while another goal implies an increase in costs.

The second issue can lead to problems between network partners when one actor needs a (sub) goal to be fulfilled, but is dependent on another actor who has no need of or interest in fulfilling the needed sub goal or requirement. Such issues can be related to what Van

Lamsweerde et al.(1998) refer to as obstacles. When goals are defined as a set of desired behaviors, an obstacle is defined as a set of undesired behaviors. Obstacles can in that way obstruct goals to be reached. In case of this issue, an extra incentive for the responsible actor may be needed to overcome the obstacle.

The third issue deals with operational requirements or maybe even (sub) goals that emerged from the interviews, which are not assigned to any network partner, so nobody takes any responsibility for its fulfillment. This results in higher goals not being fulfilled and probably the final goal as well. Another possibility is that a requirement is assigned to multiple actors, resulting in confusion of responsibility between the actors.

The analysis of the CNG Net case will be further elaborated in chapter 6.

4.3 Bottom up goal requirements modeling in general

For bottom up goal requirements modeling we can draw two main conclusions for general application.

1. To model a business network in a bottom up approach, starting with the actors, we can best model the actors and the network separately and then place the actors' models in the network model.
2. To model a business network in a bottom up approach, starting with the actors and their requirements, we should start with the requirements, but also with the main goal(s), to have a guideline of were to head to in the modeling process.

The first conclusion is based upon the fact that actors can tell what their own goals are and how they wish to accomplish them, but not with definite certainty what goals other actors pursue. They can state what another actor is meant to do, but since we're modeling the actual goals and actions of actors it is not relevant to us what an actor is supposed to do. Only what an actor actually does and pursues is relevant. Therefore, an easy way to map all the different actors' goals in the network is to model the global network and then place the separate actors' models in the global network model.

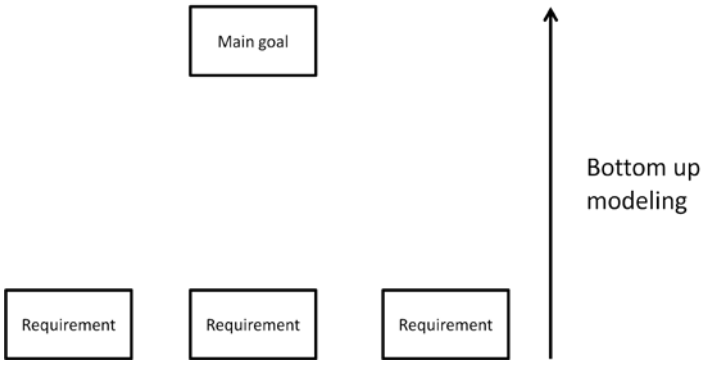


Figure 12 – Goal requirements modeling process

The second conclusion is based on the fact that goals cannot be derived with certainty merely from requirements. A requirement states an operational action from an actor, but from just the action, we cannot be certain what goal is pursued. Therefore it was found very useful in the CNG Net case to appoint the main goal of an actor or network first, to serve as a goal in the modeling process (Figure 12). In Figure 12, starting with both the requirements and the main goal, the modeling takes place from the requirements up to the main goal.

5. Linking the case study models together into value based goal modeling

A value based goal model actually consists of two models linked together, a goal model and a value model. Now we have modeled both these models, according to Figure 1 we should now link these two models into one value based goal model.

The advantage of value based modeling is the illustration of value exchanges between actors and the possibility to test or simulate economic sustainability (Gordijn & Akkermans, 2003). Unfortunately, the reasons for economic sustainability or its absence cannot always be explained through the value model. Goal models can on the other hand not explain economic sustainability, but can provide underlying reasons for it (Gordijn, et al., 2006). Gordijn et al. (2006) therefore linked these two models to illustrate economic sustainability and provide underlying arguments for sustainability, the improvement or the absence of it. They look at the value model and use the goal model to explain the economic sustainability and then use the goal model to make changes to the value constellation and vice versa.

Linkage between the models can also help during the modeling process. The value model can often be found unambiguous using information from the network partners. It is often rather clear who exchanges value with whom and in what sequence and form. From these value exchanges, one can extract the manner in which actors create income and how they spend it. In other words, how each actor (tries to) make profits. From these actions, almost one on one, goals can be assigned to actors. For instance, an actor receiving a fee for a service or good will likely have a goal stating to increase the frequency of this action or exchange of this good.

Another possible goal for the actor is to increase the quality of the service or good, increasing its value and so possibly profits. In this way, goal models can result from value models, but can also, in combination with the information provided by the actors, be used to verify the value model and the other way around. Do the goals of the actor, as uncovered during interviews comply with the value exchanges and do the value exchanges comply with the goals elicited from the actor?

During the CNG Net case study, some links between the two types of models were found, as well in syntactic structure as content of the models. These links are shown in Table 1 and Table 2. Table 1 holds links from the value model to the goal model, while Table 2 shows the links from the goal model to the value model.

Value model	Goal model
Incoming value	Goal of increasing value and frequency of income
Variable fee	Goal to increase operational returns
Fixed fee	Goal to increase number of projects
Outgoing value	Goal to decrease costs

Table 1 - Links from value model to goal model

Goal model	Value model
Conflicting goals	Decrease in economic sustainability
Enhancing goals	Increase in economic sustainability
Goal related to operational activities	Increase in long term value creation

Table 2 - Links from goal model to value model

The links from the value model towards the goal model are mainly based on structures in the value model, implying certain interests of actors, leading to certain goals of that actor. Value coming into an actor in the value model will most likely increase that actor's interest in increasing the value and frequency of the value exchange. This can be linked to in the goal model as one or more goals of the designated actor in which the actor wishes to increase the frequency and value of the value exchange.

On the other hand, outgoing value will likely increase an actor's interest in decreasing that value, i.e. cost reduction. For instance, in the CNG Net case, CNG Net earns money by selling gas, but also has certain costs assigned to gas sales. These costs are for example the construction of the CNG installation. Therefore, CNG Net will first have the goal of increasing the amount of gas sold (more gas sold means more income). Meanwhile, they will have a goal of reducing building costs of the installation. This means that they will try to minimize the construction costs per kilogram sold gas, increasing the gas sales per station (more gas sold per station means lower construction costs per kilogram sold gas, resulting in a higher profitability of the station).

Another aspect from the value model that influences the goal model is the form of the fee received by an actor (fixed fee or variable fee). The type of fee will most likely have implications for the long or short term interests of the actor. An actor receiving a variable fee will most likely be more interested in long term actions of the actor providing the fee to guarantee a long term and therefore higher and more sustainable income for himself. Therefore, the actor will share higher interests in the operational activities and possibly even tactical and strategic activities of its customer, implying a higher level of involvement and lead to efforts to improve of its assets.

On the other hand, implications on the value model could be made, based on the goal model. These implications rely on structures in the goal model and point out to certain results in simulating the value model. The first is that conflicting goals, as described on the first sign of operational problems in chapter 4.2, imply a reduction of economic sustainability. In the event that two or more actors contradict each other in their actions, which in any cooperative relationship will not lead to maximal efficiency and in some cases even to economic losses over time.
There is also a possibility that two goals assigned to one actor conflict. For example if an actor is in a so called "Stuck in the middle" strategy. In this case, the actor would pursue the goals of executing a differentiation strategy and a cost leadership strategy on the same business dimension, resulting in a poor competitive advantage (Porter, Competitive Advantage, 1985). This poor competitive advantage will lead to a reduction in economic advantage over time.

This is in contrast to the situation where two goals of network partners promote each other. In that case, actors may enhance each other's actions, resulting in higher returns for the network over time. These are the enhancing goals in Table 2.

Finally, when the goal model implies certain positive interests of one or more actors in value creation for one or more other actors, this may imply a promotion in value exchange or creation in the value model and increase economic returns over time. Practical examples are cases with high supplier involvement, such as vertical or even virtual integration. This high degree of supplier involvement increases product quality and customer value (Bhimani & Ncube, 2006) (Bidault et al., 1998) (Petersen et al., 2005) (Van Echtelt et al., 2008) (Wang et al., 2006).

The links between the models are especially important when analyzing possible problems within the network and to suggest scenarios to improve the cooperation within the network, as done in chapter 6. For example, support for problems or possibilites for improvement in one model, can be found in the other.

6. Problem solving and redesigning the CNG Net models using the value based goal model

The third sub question of this research asks for a value based goal model for a more desirable situation than the current one, and for scenarios for improvement. These scenarios can be constructed based upon literature and an analysis of the current situation, compared with a reference model (Figure 1) based upon the insights of a supervising party. This chapter first discusses the gathering of important information for the final step in the process during the CNG Net case. Then some explanation why we need the reference model, followed by an elaboration of the reference model in the CNG Net case. Finally, a number of conflicts and possible problems in the CNG Net case will be analyzed and possible solutions will be discussed.

6.1 Data collection

For the reference model, as well as analyzing problems and suggesting improvements, information on the network is needed. For the reference model, information on how the network was initiated by its supervising party must be extracted from this supervising party through an open interview.
Information that allows us to analyze the problems and suggest improvements should be obtained during the second interviewing sessions with the network partners. During the interviews in the CNG Net case study, the network actors have also been asked questions on other aspects of their strategy, relationships with other actors and value offerings to their customers.

Some of these questions aimed to get information on e^3-forces. E^3-forces is an ontological approach by the e^3-value group to model networked value constellations.
The value model of a network is supplemented with strength arrows, indicating the force of one actor onto another, based upon the five forces by Porter (1979) (Pijpers et al., 2008). These forces can be expressed by a number, ranging from 20 to 100, calculated by the formula: $strength = (\sum_j^n \beta_j \times Q_j)/5$. To achieve the score, actors have been asked to score the influence of aspects of the business force on a value exchange. These aspects are found in Appendix 5. A score of 5 indicates a high influence, 1 indicates a low influence. Scores of some aspects were then converted as shown in Appendix 5 as well, and given a weight factor β_j, in which the total sum of the weight factors needs to be 100. The weight factor was also assigned by the actors during the interviews.
The e^3-forces model shows certain pressure from one actor onto another, but also shows their buyer-supplier relationship. When there is a very heavy force between two actors, this may imply a strategic relationship, as shown in the Kraljic Matrix (Kraljic, 1983).

Another issue brought up during the interviews was the quality of the relationship between the actors. Regarding relationship quality, three main questions were asked. First, actors were asked to rate the overall relationship quality in the network on a scale of 1 to 10. This may indicate two things:

1. A low or high score may respectively indicate that an actor is involved in many or little conflicts with other actors

2. A high score in combination with many goal conflicts or operational conflicts may indicate that the actor does not perceive any problems, either because he does not care or is not used to any better.

The second question covered the possibility and extent of openly sharing information throughout the network, amongst others involving open budgeting. The third question was whether the actor thought there should be a coordinator in the network and who this should be. The answers to these two questions are important to be able to suggest possible improvements at the end of the process.

Customer values were included to investigate what values the network partners perceive to be important to them, to the other actors and to the final customers. This with respect to what the actors supply or take from other actors and to the final customers. These values are based upon Holbrook (1999), who identifies eight consumer values: efficiency, play, excellence, aesthetics, status, ethics, esteem and spirituality. Conflicts can occur when different actors perceive different values to be of importance, partly since these can also be linked to strategies and goals (Gordijn et al., 2006).

6.2 Why the reference model

Before bringing up suggestions to improve the value and goal models of the network, it is useful to check how the network was initially intended to work. There can be thought of two important reasons for doing so:

1. To check for any possible conflicts or problems in the network as originally initiated. Possible conflicts or problems can imply two things:
    a. the current network works in this way, in this case the conflict or problem should be located in the current network.
    b. the current network does not work in this way, probably caused by the conflict or problem, which the network tried to avoid by doing things differently. In both cases it is important to avoid the conflicts or problems in the initial network structure in the later suggested scenarios for improvement.
2. To check where the reference model differs from the current network. In this case it is necessary to find out why these differences occur. The current network can differ
    a. because of practical reasons (the initiated structure is not practically executable by the network)
    b. because of misinterpretation by the involved actors (they did not perceive the complete picture as initiated)
    c. because of conflicts or problems as explained under 1b above (it's practically possible to execute, but causes a lot of inconvenience)?

If the current network models deviate from the initiated network models due to misinterpretation, the initiated network models may also serve as a lead to scenarios for

improvement of the collaborations between the actors. This, of course, on the premise that the initiated network structure does not encompass any major conflicts or possible problems.

The reference goal model is somewhat less detailed than the current network goal model. The reason for this is that only the structure of the network was important to determine how the network should work. Operational details could have been of interest, but only when comparison with the model of the current situation induced this interest or raises questions. One possibility is the occurrence of conflicts between network partners on responsibilities for requirements, where the supervising party can provide clarification.

After the reference model was constructed, the model was fed back to the supervising party for validation. This revision process served to verify the model against the intention of the supervisor and to correct any errors in the model due to misperceptions or misinterpretations by the interviewer.

6.3 The reference model in the CNG Net case

In the case study of CNG Net, the reference models were drawn up from information gathered from the Chief Operational Officer (COO) of Ballast Nedam N.V., the parent company of the network. The board of directors of Ballast Nedam N.V. is the only party supervising the entire network.
The reference models are based upon an interview with the COO and were later verified in a second meeting. The value model drawn up after the interview was identical to the model derived from the interviews with the network partners and shown in Figure 7. The goal model on the other hand shows some severe differences and is shown in Appendix 3.

The main difference between this model and the one drawn up from the network partners is the difference in short term and long term profits and incomes. Although the network partners put the main emphasis on building volume and gas sales, the COO emphasizes the long term incomes generated from maintenance and management of the stations. Construction orders only create one-time revenues. Gas sales, maintenance and management create long term income. Although maintenance and management do not create income for the CNG Net business case, it will when others start exploiting the CNG market and are looking for a maintenance and management partner.

A more important target seems to be that The contractor and Beheer gather experience, information and data on the short term, so that when the CNG market hits off, they will be the undisputed market leader in maintenance and management of CNG stations on the long term. In this case, building volume is more a goal to support short term income and enable long term profits. Management and maintenance of CNG stations are intended to be a long term source of income.

One other remarkable issue is that although The management partner stated during their interview that providing the best possible asset management was their main goal, the COO of Ballast Nedam states that the profits for The management partner are the most important due to their long term sustainability. This also highlights the differences in

priorities between the actors in the network and the supervising party. The network partners put the main emphasis on building volume and gas sales, while the board of directors seems to place higher value on the long term incomes from maintenance, management and gas sales, on the condition that CNG Net is not going to be sold in the future.

The division between short and long term goals also implies that there may be options for a shift in cost and profit centers in the network. It may be more profitable for the entire network on the long term to make certain actors profit centers or cost centers (on the short term).

6.4 Analysis and scenarios for improvement in the CNG Net case

This chapter further elaborates on the possible conflicts and problems that can be derived from the obtained models. Besides, it will look into possible scenarios for improvements to overcome these problems.
As mentioned before in chapter 4.1, there are three possible problems or conflicts to be identified from the goal models:

1. Goal conflicts within the network, either being between goals or requirements of different partners or goals or requirements of one partner.
2. Goals that depend on sub goals or requirements assigned to (an) other actor(s) than the goals themselves.
3. Requirements that are not assigned to any actors.

In the CNG Net case, all three cases occur. The analysis of the goal models is based on the updated goal model after a feedback session with the network, as described in chapter 7. This updated model can be found in Appendix 3.

Another issue rose from the value model and the reference goal model, in which the reference goal model separates short and long term goals. This separation, combined with the value model leads to certain possibilities to shift costs and profits between the actors that may lead to higher profits for the entire network. This issue is discussed in chapter 6.4.4.

6.4.1 Goal conflicts

There are three main types of goal conflicts that can be derived from the models of the current situation:

1. Between cost reduction and a differentiation strategy
2. Between standardization of stations and adoption to their location
3. Minimizing building costs and improving station quality

Ad 1: Conflict between a differentiation strategy and minimizing costs
In both the building and the operational process, there is a conflict between cost minimization and the differentiation strategy followed by the network. This conflict can be explained by the generic competitive strategies by Porter (1985).

Porter states that in case of a differentiation strategy, the firm seeks to be unique along a set of dimensions that are widely valued by customers and is rewarded for this uniqueness with a premium price. These differentiations can occur by means of product features, but also amongst others on the distribution system and market approach (Porter, Competitive Advantage, 1985).

Cost minimization on the other hand is linked to a cost leadership strategy, where the firm tries to be *the* low cost producer in its industry, delivering a no-frills product and emphasizing on all forms of cost reduction. Pursuing both strategies will lead to a so called "Stuck in the middle" strategy, which obviously leads to below-average performance since the differentiators, cost leaders and focusers (Porter's third generic strategy) will be better positioned in the market (Porter, Competitive Advantage, 1985).

Suggested solution

Hendry (1990) and even Porter (1985) state that a differentiator should not ignore costs and that cost leaders should not ignore differentiation. Cost reductions can be made without harming the differentiation. For example, if a firm differentiates on the customer experience in acquiring the product, it can still cut distribution costs without harming differentiation. In the same way, a cost leader can differentiate, as long as it doesn't harm its cost advantage. This also illustrates the difference between cost reduction and cost advantage, described by Porter (1985).

Cost advantage is what is pursued by cost leaders to achieve competitive advantage over their competitors. Cost reduction can entail any form of cost reduction, but does not automatically imply cost advantage. The goal of minimizing costs in the CNG Net case implies cost reduction without the explicit pursuit of cost advantage and does therefore not have to form a conflict with the differentiation strategy.

Porter also states that in this way, a company can eventually even manage to achieve both, cost leadership and differentiation, as long as one doesn't harm the other. The conflict mainly occurs when cost reduction and differentiation are executed on the same dimensions. In the case of CNG Net, cost reduction takes place in operational efficiency and building costs, but differentiation takes place in customer experience. Therefore, a resolution has already been carried out by the network itself.

Ad 2: Conflict between adoption to location and standardization of stations

The goal model of the CNG Net case shows that one of the requirements of CNG Net in the operational process is to adopt a station to its location, which is needed to achieve the goal of minimizing connection and transport costs of gas and electricity, leading to lower operational costs. CNG Net pays according to the peaks in their intake of gas from the network over a certain period of time. Therefore it is in their interest to have (1) a steady intake of gas (as little peaks as possible) and (2) a very graduate intake of gas (lowest peaks as possible).

Technically and practically, this means that there is a need for a compressor with the smallest possible capacity (but still large enough to ensure the buffer doesn't run empty). On the other hand, adoption of the station to certain locations conflicts with the needs of the construction and design department of The contractor. For them, to achieve low building costs, it would be more favorable to standardize all stations (economy of scale). This also applies to the maintenance branch of The contractor, for whom it is cheaper and easier to maintain one kind of station, due to spare part inventories.

Besides, high capacity compressors are cheaper to maintain, therefore, in contrary to CNG Net, The contractor desires compressors with the highest possible capacity. A clear conflict emerges here when cost reduction of one party result in increased costs for the other.

In many instances, after a station is built, or the decision has been taken to build one, there is a fierce discussion between CNG Net and The contractor. This discussion emerges from the feeling at CNG Net that they are not offered the cheapest or optimal station possible to reduce their operational costs. The feeling at the maintenance department of The contractor is that there has been very little attention spent with regard to maintenance costs and efficiency.

Suggested solution
For the part where customization conflicts standardization in terms of economies of scale and spare part inventories, all three parties involved (CNG Net, The contractor design and construction and The contractor maintenance) have already worked towards a rather balanced situation. Current stations are modularly built and for each module there are a few versions which differ in, for instance, capacity. In this way, a certain degree of customization is achieved, without the need for an excessive number of parts.

The adoption of the stations to reduce connection and supply costs, versus the adoption towards the reduction of maintenance costs is a result of the investment decision process. CNG Net takes the decision whether to build a station or not, based on a price quote for a certain station from The contractor. This process is further elaborated on later in this chapter, discussing the instances where goals are assigned to one actor, but rely on requirements assigned to another actor.

Ad 3: Conflict between minimizing building costs and increasing station quality
There is a logical conflict between the goal of increasing the station quality and the goal of minimizing building costs. To build a higher quality station automatically increases the building costs of that station. So there is need for a balance between station quality (reducing down time and maintenance costs) and building costs.

Suggested solution
In practice, there is already some sort of balance between the two. This conflict can be approached a little like the differentiation strategy versus cost minimization. Building costs can be reduced, as long as station quality is kept at an acceptable level. Further, building cost reductions will have to be balanced with possible increases in operational

costs. Nonetheless, there still seems to be a conflict due to lack of trust between the different actors. This conflict might be countered by making budgets transparent, reducing distrust and making it easier to balance certain costs. This will be detailed later in the description of the decision process.

6.4.2 Unassigned requirements

The second type of problems identified is requirements not assigned to any actor. In the CNG Net case there I found only one example, which is the financing of station improvements to reduce breakdowns and damages (improve station quality).

Ad 1: Financing station improvements
The requirement in this case concerns the financing of improvements to stations to reduce break downs and damages by third parties. Unfortunately, asking the network actors, there is no consensus on who should finance improvements or modifications to existing stations to reduce break downs or damages.

Suggested solution
According to the contracts between CNG Net and The contractor, CNG Net compensates The contractor for maintenance with a fixed sum per sold kg of gas. Therefore, it is in the interest for The contractor to reduce the number of breakdowns and damages. Since both, break downs and damages are covered by the maintenance contracts, it is the responsibility of The contractor to introduce and finance improvements to stations that reduce the number of breakdowns and damages, even though this is also an advantage to CNG Net and The management partner.

6.4.3 Requirement dependency

This situation implies a problem closely related to the level to which actors collaborate. If one actor is partly (or in some cases fully) dependant on other actors to reach its goal, its relation with these actors becomes vital.

In the case of CNG Net, there are two instances where this situation occurs. The first is The contractor's goal to maximize the building assignments within Ballast Nedam. Although this is their goal, they mainly rely on requirements of CNG Net to reach it. The other case concerns a goal of CNG Net (Minimize building costs), which relies on requirements of The contractor. These two together with the earlier discussed conflict in operational costs between CNG Net and The contractor originate from the investment decision process. This process occurs after The contractor proposes a location for a CNG installation. In the current situation, CNG Net requests for a quote for the installation at The contractor and considers the market potential and operational costs to determine the potential of ample returns on the station. According to these estimated returns, they make an investment decision.

In this process, there are several frictions between the different actors:

1. Ballast Nedam's construction department does not always understand why locations are rejected. They feel locations are rejected on issues they could have

easily solved if they were allowed input in the decision making process, leading to frustration on the side of The contractor. CNG Net on the other hand argues that The contractor does not sufficiently consider market potential when selecting locations and approaching station owners.

2. CNG Net perceives that The contractor does not always present them the most optimal offer. Despite the fact that building costs have gone down significantly over the past few years, they still believe it is possible to get them even lower. They also feel that The contractor's construction and maintenance departments mutually agree on a station that is most convenient to them, not to CNG Net.
3. The contractor's maintenance department states that stations are often built regardless of their part of the total operational costs. They feel that stations are only built on the premise of low operational costs for CNG Net, regardless of maintenance costs. This leads to firm conflicts after the investment decision has been taken and often after the station is built. This also invalidates the discussion between the two The contractor departments about station design, as suggested by CNG Net in the previous point.

To counter this, one may encourage The contractor to find better locations to reduce the friction. Some actors within the network have opted for variable rewards for the construction department of The contractor, since the other actors also receive variable rewards. Looking at the value model of the network, there are two options to solve this:

1. Change the fixed compensation for The contractor for building the CNG station to a variable one, dependent on the kilograms of sold gas.
2. Change the fixed compensation for The contractor for selecting locations to a variable one, dependent on the kilograms of sold gas.

The first option would increase the interest of The contractor in selecting a location with high returns. It will even make it almost fully dependent for its income on market potential and sales. Nonetheless, the problem is that this would mean that The contractor would have to make the investment for the stations and The contractor is not a venture made to do large investments, CNG Net is. By countering the problem in this way, we would only move the problem.

The second option offers more opportunities. For finding the location, there is no need for a large investment from The contractor. They search for a location and in case this location is approved, they gain a fixed reward. Currently, The contractors construction department's is only limited to a constraint in the goal model of operational processes. Introducing a variable reward will introduce a goal for them in this part of the model implying an incentive to find better locations by giving the construction department of The contractor an interest in the operational aspects of the CNG stations. In the goal model, this would imply that the construction department of The contractor will also have goals in the model of the operational process.

Looking at all three frictions simultaneously, a recurring item is appearing to be a lack of trust between the three involved actors. Secondly, going through the current decision process, there are three steps in this process:

1. CNG Net requests for a quote for a CNG installation at The contractor, who give a quote for a station of which it is not clear whether this is the most optimal on maintenance costs and of which CNG Net claims it is not optimal for their operational costs.
2. CNG Net takes an investment decision, based upon their perceived market potential, expected operating costs and the quote offered by The contractor.
3. CNG Net seems to be content with the decisions taken to build stations. The construction department of The contractor is often unsatisfied with decisions not to build, since they do not understand the grounds for the decision. The maintenance department of The contractor feels that decisions are taken only on the account of CNG Net's operational costs, not on total operational costs.

These three steps incorporate more conflicts than fruitful cooperation. One way to enable better cooperation with less conflict would be to include the construction department of The contractor and The management partner in the decision process as well. Still leaving the decision to CNG Net, these two other actors bring in much useful information. The maintenance department of The contractor will not be included, since it will imbalance the discussion in the favor of The contractor. The reason to include partners in this decision process relies on the following.

Supplier involvement is repeatedly found to be a positive moderator of product development, as amongst others shown by Bidault et al. (1998), Petersen et al. (2005) and Van Echtelt et al. (2008). Van Echtelt et al. (2008) advocate that suppliers can enhance better targeting of improvements, allowing for improved final products (Echtelt et al. 2008). They also illustrate the underpinning in literature that supplier involvement is more effective in cooperative buyer-supplier relationships opposed to adversarial approaches and the success factors for effective collaboration, being high trust, management commitment, information sharing and risk and reward sharing (Echtelt et al. 2008). Petersen et al. (2005) show that supplier involvement leads to improved quality and cost reduction of new products. Trust between partners is also advocated by Zaheer et al. (1998), who show that trust between suppliers and buyers increases performance and decreases conflict and negotiation costs. Trust also happens to be something lacking in the CNG Net case.

De Man & Roijakkers (2009) mention the differences in control based alliances and trust based alliances. They state that a control based alliance, based mainly on contractual agreements, will result in firms optimizing the results of the alliance for their own organization. On the contrary, in alliances based upon trust firms will seek to optimize results for the entire alliance, since they more often believe that what is good for the alliance will be good for the individual partners (De Man & Roijakkers, 2009).

From a paper on virtual integration of supply chains in the construction industry, based on literature on virtual integration, relationship quality and partnering in the construction industry, one of the conclusions is that the degree of trust between partners is strongly increased by transparency in budgeting and open information sharing, for instance by supplier involvement (Tigchelaar, Radstok, & Melis, 2011). The paper can be found in Appendix 6.

In short, one can conclude that supplier involvement leads to better product development, reduction of costs, less conflicts and decrease of negotiation costs and that these are positively moderated by a cooperative relationship. The contractor is a supplier to CNG Net, and including them into the decision process will allow for the advantages of supplier involvement.

Secondly, including The contractor in the process will enable an open dialogue between CNG Net and The contractor, positively affecting trust between the two actors. Besides promoting the cooperation between the two (by decreasing conflict and negotiation costs), trust will also have its long term benefits. CNG Net belongs to Ballast Nedam Consessies, which has more subsidiaries working together with The contractor.

As Zaheer et al. (1998) also show, there is a clear positive correlation between interpersonal trust (in this case between CNG Net and The contractor) and interorganizational trust (between Ballast Nedam Consessies and The contractor). Trust in this network will have its advantages in other projects as well, both now and in the future. Besides, a relation with accumulated experience between two partners can result in more efficient and effective partnering in future projects (Van Echtelt et al., 2008).

The inclusion of The management partner in the process can counter the conflicts regarding operational costs. The management partner has insight in all operational costs, both CNG Nets costs and the maintenance costs. They are best positioned to overlook the balance between the costs of different actors, better than CNG Net is.

Also they have a more neutral stake in the whole picture, compared to the other actors. Inclusion of the The contractor maintenance instead of The management partner would create an imbalance between actors in the negotiation processes (two of the three actors would then originate from the same business entity).

Including multiple actors into the decision process, provides these actors with more intrinsic motivation for the alliance. According to De Man & Roijakkers (2009) this will lead to less opportunistic behavior by network partners and more trust between them, which in turn will lead to better enactment of the partners in the interest of the entire alliance.

Another reason to include both actors in the process can be found in purchasing literature. Looking at the portfolio approach by Kraljic (1983), despite medium scores assigned to the e^3-forces by the actors during the interviews, we can identify the relationship within the network of the CNG Net case as a strategic one.

In this we consider that (1) the impact of the relationship on financial results is high for all actors involved, the vast majority of either their costs or their income relies on the cooperation within this network and (2) they are bound to each other, implying a dependency that can be related to supply risk (the horizontal dimension in the Kraljic matrix). Van Weele (2004) argues that in cases of strategic partnerships, there are three options for power balance: buyer domination, supplier domination or a balanced relationship.

In the current situation, CNG Net has a more powerful position in the network, since the investment decision is solely in their hands. This implies a buyer dominated relationship between CNG Net and the other actors in the investment decision process. Suppliers will often experience this a one sided relationship. It is more desirable to form a balanced relationship, which over time is more likely to form a partnership relationship (Van Weele, 2004). For such a strategic relationship, a performance based partnership is found most relevant and effective. Such a partnership is to be aimed at collaboration and to create mutual participation and mutually agreed cost and operational targets (Van Weele, 2004). This collaboration in the CNG Net case would require input from at least one actor in the building process and one more from the operational process, to include input beneficial to all partners and to equal the power balance.

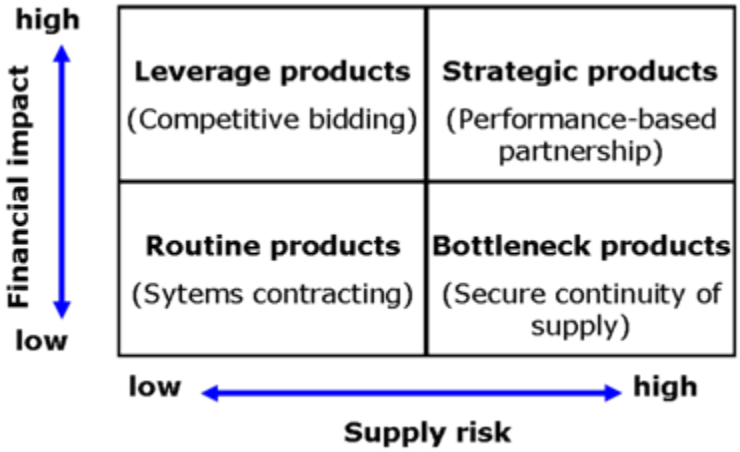


Figure 13 - Kraljic matrix

Finally, Van Weele (2004) also demands an 'open costing' structure in performance-based partnerships. Opening up budgets also leads to an increase of trust as mentioned before.

6.4.4 Shifting of costs and profits

Due to software limitations it was found impossible to reliably model the value network's models. Nonetheless, certain aspects were revealed after entering the value exchanges in an Excel sheet. From this sheet, found in Appendix 7, it became clear that several numbers do not have any direct impact on the network's total gross profits, since they remain within the network. One of the most important of these is the margin for The

contractor on the CNG Station. This is paid by CNG Net to The contractor, meaning that money will remain in the network, only IPM is making profits, on the account of CNG Net. CNG Net on the other hand, bases its investment decision partly on the initial building costs of the station, in which a price difference of **XXX** results in a raise of profitability of **X**%. Taking in account the short and long term goals of the reference goal model as shown in Appendix 4, it is said that on the short term, the market will be developed, in order to obtain long term profits from gas sales, management and maintenance. Logically, the network should put all efforts in building as many profitable stations in a short period of time to quickly develop the market and enable The management partner and The contractor to gather experience and reduce costs in management and maintenance of stations. Therefore it does not seem logical that actors place margins on their exchanges with other actors within the network, which can negatively influence the investment decisions. As can be seen in the difference between Appendix 7a, showing an approximation of the current situation and Appendix 7b, showing the situation when **XX** extra stations can be built annually because of the absence of profit margins within the network. Appendix 7a is based on a situation where, over time, costs for gas, stations and maintenance remain the same. However, Appendix 7c and 7d show the impact when respectively gas prices and maintenance costs are reduced by **XX** percent (either due to focusing on cost reductions for CNG Net or cost reductions for The contractor's maintenance department).

6.5 Conclusions of the analysis

From chapter 6.3 and 6.4, we can draw several conclusions, based upon the bottom up value based goal modeling process.

First, what seems remarkable is the difference between perception of the intention of the network between the network actors and the supervisor. From the reference model. It became clear that the network was intented with short term goals and long term goals, though the network actors did not percieve this to happen.

Secondly, it seems that most goal conflicts are already solved within the network by the actors themselves, who have already sought a balance between conflicting goals. For example, a balance between customization and standardization of stations.
On the other hand, the obstacles presented from the models, obviously still house a lot of room for improvement. From the models, it was found that certain actors depend on others to reach their goals, while the actors they depend upon do not always have direct interests in reaching those goals. Therefore, we should look for ways to change the goal models in such a way that this interest is created or these dependencies are weakened. Certain ways to do so in the CNG Net case is by using a higher degree of supplier involvement, vairable fees for all actors and open budgetting.

Based upon the vlaue model, we can conclude that profit margins accounted between network partners do not have any positive influence on the overal profits of the network. Instead they have a negative influence, for example in the CNG Net case where the profit

margin retained by The contractor on the construction of CNG stations negatively influences the investment decisions.
From the value model we can see that it may be more profitable to lay optimal profits or a higher decrease in costs at one actor or certain actors. This is dependant on which cost reduction has the highest long term impact on the network's profits.

7. Validation

The conlcusions drawn in chapter 6 are, nevertheless, based solely upon the modeling process and analysis as described in chapters 3, 4, 5 and 6. In this chapter, I will discuss the validation of these models and anlysis, and therefore the modeling process for the CNG Net case. The validation is based upon sessions with the network actors and the COO of Ballast Nedam and serves as a support for the models, analysis and drawn conclusions.

To validate the CNG Net case study, two sessions were held with the network partners together and one with the COO of Ballast Nedam. The aim of the first session, a feedback session with the network partners, was to validate and verify the models constructed from the information gathered during the interviews. After this session, the models were updated where necessary. The second session, the validation workshop with the network partners, was used to validate the problem analysis through the models and the suggested solutions.
Finally, a feedback session with the COO of Ballast Nedam took place around the same time as the first session with the partners and served to verify the reference model before it was used to analyze any problems in the network and to indicate possible solutions for these problems.

7.1 Feedback sessions

After the models were designed based on the input from the interviews with the actors from the network, a feedback session was held with all actors together. This session served four purposes:

1. To validate the value model with the network partners
2. To validate the goal model with the network partners
3. To discuss the reference model with the network partners
4. To look for possible solutions emerging from the models with respect to their effectiveness and feasibility

The first two points were brought in for two reasons. The first was to verify the models. During the interviews, the actors answered questions about their collaborations within the network and both their goals and the networks goals. There is a risk of misinterpretation by the interviewer and bias of the respondent. For instance, respondents can be biased due to previous experiences, (temporarily) influencing the vision of the respondent and his answers during the interview (Blumberg, et al., 2008). The interviewer can interprete the answer differently as how the respondent intented it. To overcome these issues, the models as in Figure 7 and Appendix 2c were presented to the network for feedback.
The second reason to present these models was to validate the interviewing method, i.e. the correctness of the models would indicate the validity of the research so far.

The third point mentioned above involved presenting the reference model to the network actors and see to what extend they were acquainted with their supervisor's vision, and if they agreed with it. These two aspects could provide valuable insights regarding possible differences between the reference model and the network model.

The fourth point, introduced during the session, was to pre-test any suggested results from the problem analysis and possible improvements with the network. In this way, problems could be discussed beforehand to see whether they fit the ideas, perception and experience of the network partners. Possible improvements that rose from the models and interviews were discussed with the network partners to see whether the improvements are feasible or could be effective.

As well as the feedback session with the network, a feedback session with Ballst Nedam's COO was held. The reference model, conflicts that were discovered and possible sollutions, were presented to the network partners. This was done for the same reason as in the network feedback session; to test the acknowledgement of these conflicts and attitude towards the possible improvements.

7.2 Results from the feeback sessions

The feedback sessions with the network actors and Ballast Nedam's COO, resulted in the following outcome.

7.2.1 Verification of the value model with the network

During the feedback session with the network, the value model as drawn up from the interview results was presented. All actors agreed with the model, as also shown in Figure 7, except that the connection to the gas network was not obtained from the gas supplier but from the network manager. This is just a minor change to the network, since it does not involve any serious implications for the outcome of the model. Regarding everything else in the structure and contents of the model, all partners agreed.

7.2.2 Verification of the goal model with the network

During the feedback session with the network, the goal model as shown in Appendix 2c was also presented to the network actors. Although they agreed with the overall structure of the model, two main issues were opted:

1. According to the network partners, emphasis in the operational processes (gas sales and related activities) should be more on gas sales per station and operational availability of the stations as this is a common goal for all actors involved in the operational processes (BN IPM maintenance, BN Beheer and CNG Net).
2. The model may become clearer and easier to interpret when a division is made between the building process and the operational process. So that there are actually two goal models of the activities in the network as well as one regarding each dependency path in the value model.

These issues where adopted, resulting in the goal model shown in Appendix 3, in which a division has been made between the building process (on the left) and the operational processes (on the right). Through this division it became clear that the construction

department of The contractor doesn't have any goals in the operational process, only a requirement (as discussed in chapter 6.4.3).

Another change made to the model concerned a goal for The contractor's maintenance department. It changed its goal for high maintenance volume, into a goal of maintenance cost reduction and increasing gas sales per station. The contractor gets, nonetheless, a variable fee per kg sold gas, not per maintenance volume. Although this was not mentioned directly during the feedback session, it became clear while remodeling towards the emphasis of gas sales per station.

7.2.3 Discussion of the reference model with the network

Presenting the reference model to the network resulted in a surprising outcome. The network partners had not made the division between short term and long term goals, or on operational level between building and gathering experience in the short term and emphasizing on management and maintenance on the long term. They had thought about this, but on an operational basis it had never been an issue for any of the partners. The main reason they gave for this was that they claim they were not expected to work in this manner. They feel to be directly accountable for their annual profits and losses as separate entities, not as a network. They felt that the division between short and long term also required that they should not be directly accounted for eventual losses due to the short term vision.

7.2.4 Discussion of problems and possible improvements with the network

Three main problems were already presented to the network, which are the problems related to the investment decision, the operational costs and the financing of improvements to reduce damage caused by third parties, as discussed in chapter 6.4. These problems were all acknowledged by the network partners.
Possible improvements to the current situation were suggested broadly. These were the variable fees for The contractor's construction department, the inclusion of more actors in the investment decision process and opening up budgets between the actors. All network partners agreed that these were reasonable options.

7.2.5 Verifying the reference model

When showing the value and goal models to Ballast Nedam's COO he did not seem to have any remarks. The value model, as well as the goal model was agreed on in its entirety. The only severe comment was that The contractor was modeled as two separate identities, while they were originally initiated to act as one identity.

7.2.6 Discussion of problems and possible improvements with the supervising party

The same problems and suggested improvements as discussed with the network partners were also presented to Ballast Nedam's COO. Although the actors from the network were rather positive about the problems and suggested improvements, Ballast Nedam's COO was rather skeptical. He did agree with the analysis and denomination of possible problems, but not with the fact that the discussions between the actors in the investment decision process created a problem. Since this process in its current form and the

discussions and conflicts emerging from it had already brought down station costs with approximately 40%, this process was not considered as negative and he did not think that inclusion of other actors than CNG Net in the decision process was particularly necessary. Inclusion in the process could be possible, but the final decision should remain at CNG Net. Despite skepticism towards the inclusion of multiple actors in the investment decision, the option for open budgeting was found to be a reasonable option for improvement of the collaboration.

7.3 The validation workshop

At the end of the research, one more session with the network partners was held. This session served to validate the entire case study, by looking at four aspects:

1. Do the network partners still agree with all the models drawn up from the interviews, after they were updated after the feedback session
2. Do the network partners acknowledge the problems as finally illustrated and analyzed from the models
3. How do the network partners face the proposed scenarios for improvement
4. Do the network partners percieve that the research:
    a. Helped to illustrate and analyze possible problems in their colalboration
    b. Was of any use in improving their collaboration and suggesting useful options for improvements

7.4 Results from the validation workshop

Here I will discuss the outcome of the four issues mentioned in chapter 7.3 and what was discussed during the validation workshop.

Ad 1: Agreement of the network partners with the models

After presenting the models as drawn up from the interviews and updated after the feedback session, there were no major issues according to the partners. The models were clear to all partners, though they percieved that the value model was made less complex. The only change with regard to the earlier model in the feedback session was that the provision of the gas connection was placed in a new actor, the network manager instead of the gas supplier.

Ad 2: Acknowledgement of problems

There was no critique on the goal conflicts illustrated in the models. Regarding the other problems, CNG Net acknowledged that it would indeed be positive when all actors would have an interest or goal in the operational processes.

Regarding the financing of improvements to stations, there was still some discussion. Although Ballast Nedam's COO stated that financing such improvements would be the responsibility of The contractor (the maintenance department), since it results in cost reduction on their account. The contractor on the other hand argues that it will also improve the operational availability of the station, therefore increasing gas sales of the station and is therefore also in the interest of The management partner and CNG Net.

The other main issues, those regarding the investment decision and operational cost reduction, were indeed acknowledged by all partners to be major sources of conflicts in their collaboration.

Ad 3: Network partners' visions on scenarios for improvement
During the validation workshop, four scenarios for improvements were presented:

1. Variable fees for the construction department of The contractor regarding the location selection
2. Inclusion of The management partner and the construction department op The contractor in the investment decission process
3. Open budgetting
4. Shifting costs and reducing margings accounted within the network, according to the short and long term vision

Regarding the variable fees for location selection by The contractor, there was some interest from CNG Net and The management partner, who indeed felt that this may enhance The contractors interest in operational processes and the way they select locations. The contractor, especially the construction department, was rather skeptical. They felt that it will not resolve anything, since the main problem according to them lies in the way that account managers from The contractor and CNG Net work together in the selection process. CNG Net and The management partner suggested that this could be solved by forming better teams between these account managers or maybe placing them all under one actor. Although The contractor remained skeptic, the other actors seemed rather positive about this scenario. One partner placed the remark that variable fees would not make a difference because it entailed a fee that remains within the network. The variable fee, nonetheless, is meant as an incentive and indeed, since it remains in the network, it doesn't make any difference on the networks bottom line.

The inclusion of The management partner and the The contractor's construction department was very positivley received by the entire network. It would give the The contractor's construction department better insights in why locations are rejected and provides them with the opportunity to find ways to overcome this rejection. They argue that due to their technical knowledge and close contacts with the station owner they can bring in very valuable information and options to make the station profitable or more interesting to all stakeholders. The management partner on the other hand has the entire overview of all operational costs, including purchasing gas and maintenance costs. They can help in the decision of whether to raise one of these costs for the benefit of the other and what would be the most profitable balance for the entire project. All partners agree that The contractor's maintenance department should not be included because it would imbalance the discussions, as was also mentioned in chapter 6.4.3. They also unanimously agree that the final investment decission should remain with CNG Net alone.

To enable this way of collaborating, in which multiple partners work on the best solution for the entire network, there will be a need for open budgetting. Open budgetting will

provide the possibility to overview all costs and benefits for all parties involved and therefore enable better decisions in favour of the entire project instead of the separate entities. Despite that Ballast Nedam's COO indicated during the feedback sessions that this was definitely possible within Ballast Nedam, none of the network partners percieved this as being possible within Ballast Nedam.

Regarding the shifting of costs according to short and long term goals in the reference model and with regard to the value model of the network, the partners are very interested. Especially from The management partner, there was a fierce interest in the effects of reducing gas purchasing prices opposed to other costs and looking at the effect it has on the final network profits. Also the decrease of margins accounted within the network, for instance by The contractor on the construction of the CNG station received some severe interest by the network partners. They mentioned multiple times that they feel that they are less price efficient that their competition, due to margins accounted between Ballast Nedam subsidiaries.

Ad 4: General view by the network partners on the research

Regarding the entire research, the actors indicated they found the research very inetresting and helpful. They perceived that value based goal modeling clearly illustrated the way they work together as well as illustrating any conflicts or problems in this collaboration.

The actors pointed out during the validation workshop that they perceived the models as very useful to them and that the research itself envoked more discussions between them on how to improve collaborations within the network. For instance certain interview questions and the feedback session had already triggered them to start working on problems that were made clear during this research . This was considered to be a very positive effect of the research.

Finally, something that struck one of the partners most is the difference that became clear between the way they work together, the way they were supposed to work together according to the reference model and the way they were able to work together due to the structure of Ballast Nedam.

8. Conclusion

The conclusions of this research can be divided into two sections. Frist conslusions with regard to bottom up value based goal modeling, as well in the CNG Net case as in a general sense and second conclusions with regard to the case study of CNG Net itself.

Beside these two conclusions, I will also discuss the limitations of this research project and the recommendations in this chapter.

8.1 Conclusions with regard to bottom up value based goal modeling

For bottom up value based goal modeling in general, there are three conclusions that can be drawn from this research, based upon issues found during the modeling process.

The first is that it is more conveinient to start with the value based model and then proceed to the goal model, since the value model was found to be modeled easier from information extracted from the network actors. Besides, several goals did follow from the structure of the value model, as shown in chapter 5 of this thesis.

The second conclusion is that it is hardly possible to construct the entire goal model from merely requirements mentioned by the actors. Therefore the main goal(s) of the actors and the network are needed as a guideline for the modeling process. When working with interviews with the separate actors to gather information, it will also be necessary to split the model into smaller models per network actor and then merge these into a global model for the entire network, due to the inability of actors to accurately describe the true goals of other actors.

The third general conclusion is that, when extracting information on the network through interviews in bottum up value based modeling, it seems more appropriate to model the dependency path together with the actors and their actions directly into a global model. From this global model, a detailed model can be derived.

It is hard to draw any general conclusions with regard to the scnearios for improvement, since every network is different. The main thing is that one should always look for a way to overcome a conflict or obstacle. Especially in the case of obstacles, it is usefull to look at the structure of the goal model and find alternative structures which would overcome the obstacle. One example is the addition of goals and/or requirements for actors, as done in chapter 6.4 by supplier involvement.

With regard to the CNG Net case, it was found that bottom up value based goal modeling served as a very useful way of illustrating the interactions in the network, pointing out conflicts and possible problems and suggesting improvements. The network partners also indicated that the research itself already evoked discussions and led to steps for improvement. Nonetheless, there were also some issues found during the feedback session especially, where the results of the modeling did not exactly match the real world, which underpins the need for validation of the models with the network during the feedback session.

8.2 Conclusions and recommendations with regard to the CNG Net case

Regarding the CNG Net case, it can be concluded that there is definitely some room for improvement in the way the actors work together. Especially with respect to the decision process of whether to build a station or not, and how to build the station to the optimal benefits of the entire network. Closely linked to these two is the issue of trust. Once the trust issue between partners has been resolved, the decision making process is also likely to be improved. Inclusion of several actors in the investment decision process will improve the decisions making itself. In combination with open budgetting, this improved decision making process can lead to much higher profits in the network, since decisions are made on behalf of the alliance, not on individual benefits of the partners. Even when the decision process involves multiple actors who work together cooperatively, it is inevitable that some disagreements and friction will remain, since every alliance relationship contains self-interested behaviour of alliance partners (De Man & Roijakkers, 2009).

Budgetting based on projects instead of business entities will also provide better means to make the division between short term and long term goals, nonetheless, there should be a focus on the possibility for partners to act this way. There should be a thorough examination of the structure of Ballast Nedam and to what extend this short term and long term division fits the company and whether project budgetting is possible. For the short term goals, actors should for instance be allowed to make losses on the short run and to optimize quick market development, it may be necessary to use open budgetting and horizintal budgetting per project instead of vertical budgetting per business entity. According to Ballast Nedam's COO, this is already the case, the network partners on the other hand percieve something very different.

8.3 Limitations

The main limitation of the research with regard to the bottom up approach of value based goal modeling is that it relies solely on one case study. Therefore, not all conclusions mentioned above can be generalized. Some can only be drawn with regard to the case study. The general conclusions mentioned in chapter 8.1 are based on the case study and were found to be general, since they regard limitations found during the modeling process. These were unfortunately not validated, so there is no absolute certainty about them.

Another limitation to the method used here is that during the feedback sessions, the reference model is discussed with the network partners. To discuss this model, it should first be verified with the supervising party. During the feedback session with the supervising party, possible problems were discussed with Ballast Nedam's COO, which were based upon the models drawn up from the interviews with the network actors. Therefore, a vicious cicle emerges in this approach: For a correct feedback session with one party, a model is needed that is validated with the other party and vice versa. During the research process, the network partners were therefore presented with a reference model that was not yet verified with the Ballast Nedam's COO, which can be regarded as a potential weakness of the research.

8.4 Recommendations

In the current situation, only the CNG Net case study is validated. To validate the entire method used in this research and the bottom up approach for value based goal modeling, at least one more case study on a comparable network should be conducted according to the same method, to see whether it will give the same results.

References

Bhimani, A., & Ncube, M. (2006). Virtual integration costs and the limits of supply chain scalability. *Journal of accounting and public policy* , 390-408.

Bidault, F., Despres, C., & Butler, C. (1998). The drivers of cooperation between buyers and suppliers for product innovation. *Research Policy* , 719-732.

Blumberg, B., Cooper, R. R., & Schindler, P. S. (2008). *Business Research Methods.* Berkshire: McGraw-Hill Education.

Dardenne, A., Van Lamsweerde, A., & Fickas, S. (1993). Goal-directed requirements acquisition. *Science of computer programming* , 3-50.

De Man, A.-P., & Roijakkers, N. (2009). Alliance governance: Balancing control and trust in dealing with risk. *Long range planning* , 75-95.

Gordijn, J. (2002). Value-based requirements engineering: exploring innovative e-commerce ideas. *PhD thesis* . Vrije universiteit Amsterdam.

Gordijn, J., & Akkermans, J. (2003). Value-based requirements engineering: exploring innovative e-commerce ideas. *Requirements Engineering* , 114-134.

Gordijn, J., Petit, M., & Wieringa, R. (2006). Understanding business strategies of networked value constellations using goal and value modeling. *Proceedings of the 14th IEEE International Requirements Engineering Conference* (pp. 129-138). Los Alamitos: IEEE CS.

Hendry, J. (1990). The problem with Porter's Generic Strategies. *European Management Journal* , 443-450.

Hisrich, R. D., & Peters, M. P. (1986). Establishing a New Business Venture Unit Within a Firm. *Journal of Business Venturing* , 307-322.

Holbrook, M. (1999). *Consumer Value, a framework for analysis and research.* New York: Routledge.

Kraljic, P. (1983). Purchasing must become supply management. *Harvard Business Review* , 109-117.

Petersen, K. J., Handfield, R. B., & Ragatz, G. L. (2005). Supplier integration into new product development: coordinating product, process and supply chain design. *Journal of Operations Management* , 371-388.

Pijpers, V., & Gordijn, J. (2007). *E3forces: Analyzing Strategic Considerations of Actors in Networked Value Constellations.* Amsterdam: Vrije Universiteit Amsterdam.

Pijpers, V., Gordijn, J., & Akkermans, A. (2008). Business strategy-IT alignment in a multi-actor setting: A mobile e-service case. *Proceedings of the 10th International Conference on Electronic Commerce 2008.* Dieter Fensel and Hannes Werthner editors.

Porter, M. E. (1985). *Competitive Advantage.* New York: The Free Press.

Porter, M. E. (1979). *How competitive forces shape strategy.* The president and fellows of Harvard College.

Tigchelaar, G., Radstok, K., & Melis, S. (2011). Is Virtual Integration a suitable tool to improve the relationship quality between contractors and subcontractors in the construction industry? *Paper on strategic sourcing and supply management in assignment of the TU Eindhoven* .

Van Echtelt, F. E., Wynstra, F., Van Weele, A. J., & Duysters, G. (2008). Managing Supplier Involvement in New Product Development: A Multiple-Case Study. *Journal of Product Innovation Management* , 180-201.

Van Lamsweerde, A. (2001). Goal-Oriented Requirements Engineering: A Guided Tour. *IEEE* , 249-261.

Van Lamsweerde, A., & Letier, E. (1998). Integrating obstacles in Goal-driven requirements engineering. *Proceedings ICSE'98 - 20th International Conference on Software.* Kyoto.

Van Weele, A. (2004). *Purchasing And Supply Chain Management: Analysis, Strategy, Planning And Practice. 4th Edition.* London: Cengage Learning.

Wang, E., Tai, J., & Wei, H. (2006). A virtual integration theory of improved supply-chain performance. *Journal of management information systems* , 41-46.

Zaheer, A., McEvily, B., & Perrone, V. (1998). Does trust matter? Exploring the effects of interorganizational and interpersonal trust on performance. *Organization Science* , 141-159.

Appendices

Appendix 1

Questionair interview round 2 (Dutch)

Vragenlijst

1. Wat is het doel van de partner zelf?
2. Hoe wordt dit doel bereikt?
3. Wat is de strategie van de partner? Operational excellence, differentiation.
4. Wat is het uiteindelijke doel van het netwerk?
5. Hoe moet dit doel bereikt worden?
6. Wat is de netwerkstrategie?
7. Waar zou het zwaartepunt moeten liggen?
8. Hoe vind welke waarde uitwisseling plaats?
9. Wat is voor jullie belangrijk?
10. Hoe voldoen jullie de uitwisseling naar de verschillende partijen?
11. Quantificering van waarde uitwisseling.
12. Hoeveel stations per jaar en hoeveel gas per station?
13. Wat is van belangrijke waarde voor jullie mbt de service/goederen die je binnen het netwerk afneemt/gebruikt:
    a. Efficientie
    b. Kwaliteit
    c. Status
    d. Waardering
    e. Plezier
    f. Esthetiek
    g. Ethiek
    h. Spiritualiteit
14. Wat is voor de (eind)klant belangrijk?
15. 5 forces

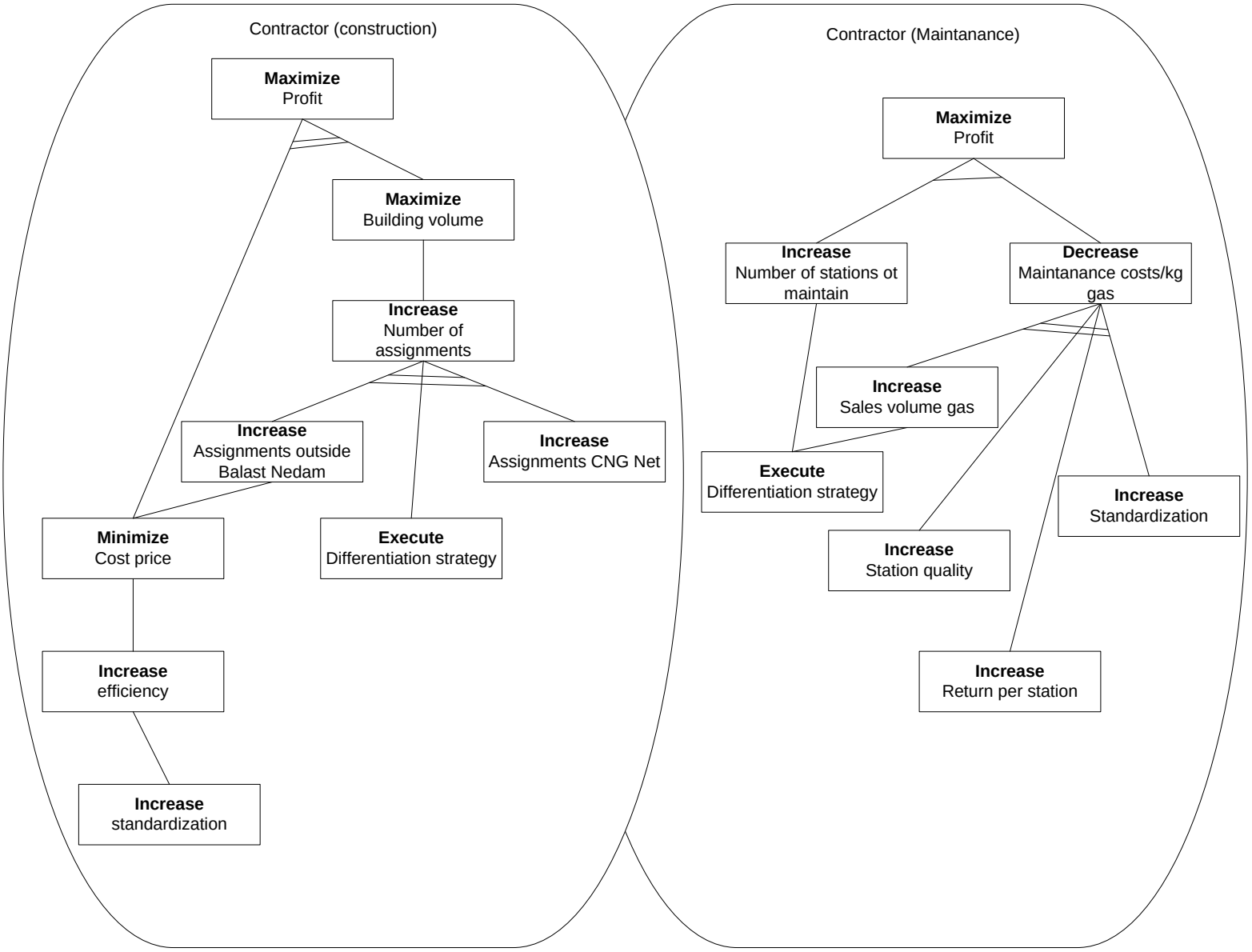
16. Hoe zou je de vertrouwensrelatie tussen de partners omschrijven?

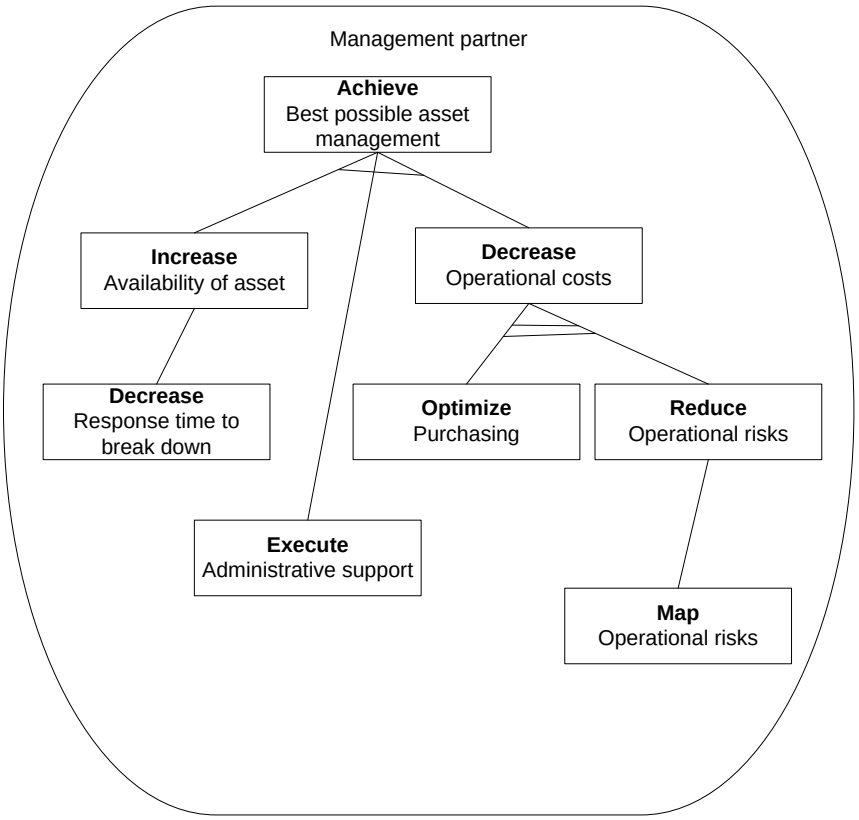
17. Is het open informatie deling haalbaar?

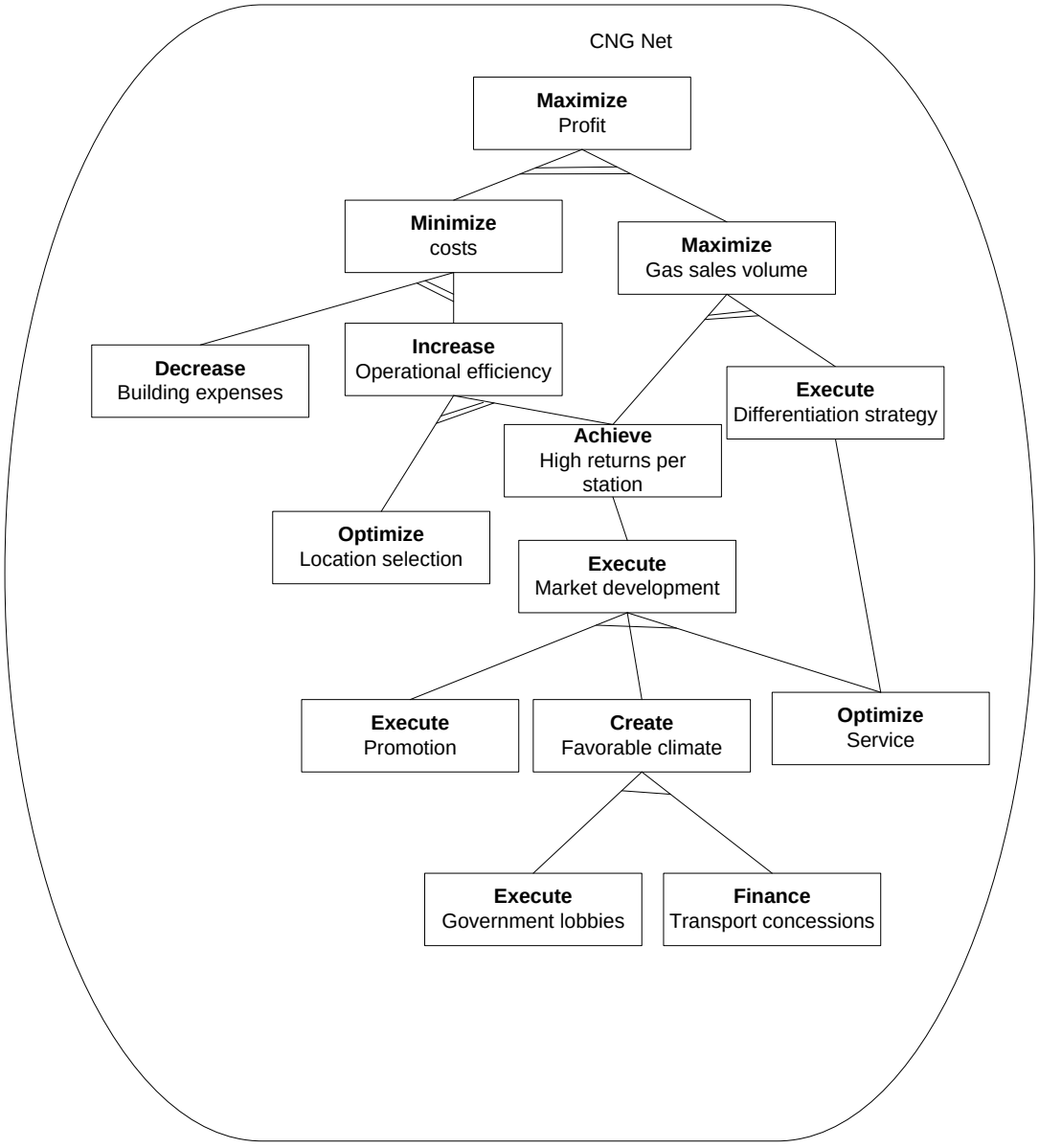
18. Zou er een coördinator in het netwerk moeten zitten, of zit deze er al? Waarom wie (niet)?

	1	2	3	4	5	
Leveranciers						
Aantal leverancies						
Noodzaak van geleverde						
Belang van afnemer voor leverancier						
Kosten voor wisselen leverancier						
Bedreiging van overname door leverancier						
Afnemers						
Aantal afnemers						
Aantal gelijkwaardige beschikbare producten						
Alternatieve leveranciers						
Kosten voor wisselen van leverancier						
Belang van het waardeobject voor afnemer						
Hoogte winstmarges						
Bedreiging van overname door afnemer						
Concurrenten						
Balans tussen concurrenten						
Groeifactor markt/industrie						
Vaste kosten						
Uitstapkosten/drempel						
Differentiatie tussen concurrenten						
Capaciteitstoename						
Opofferen van winstgevendheid						

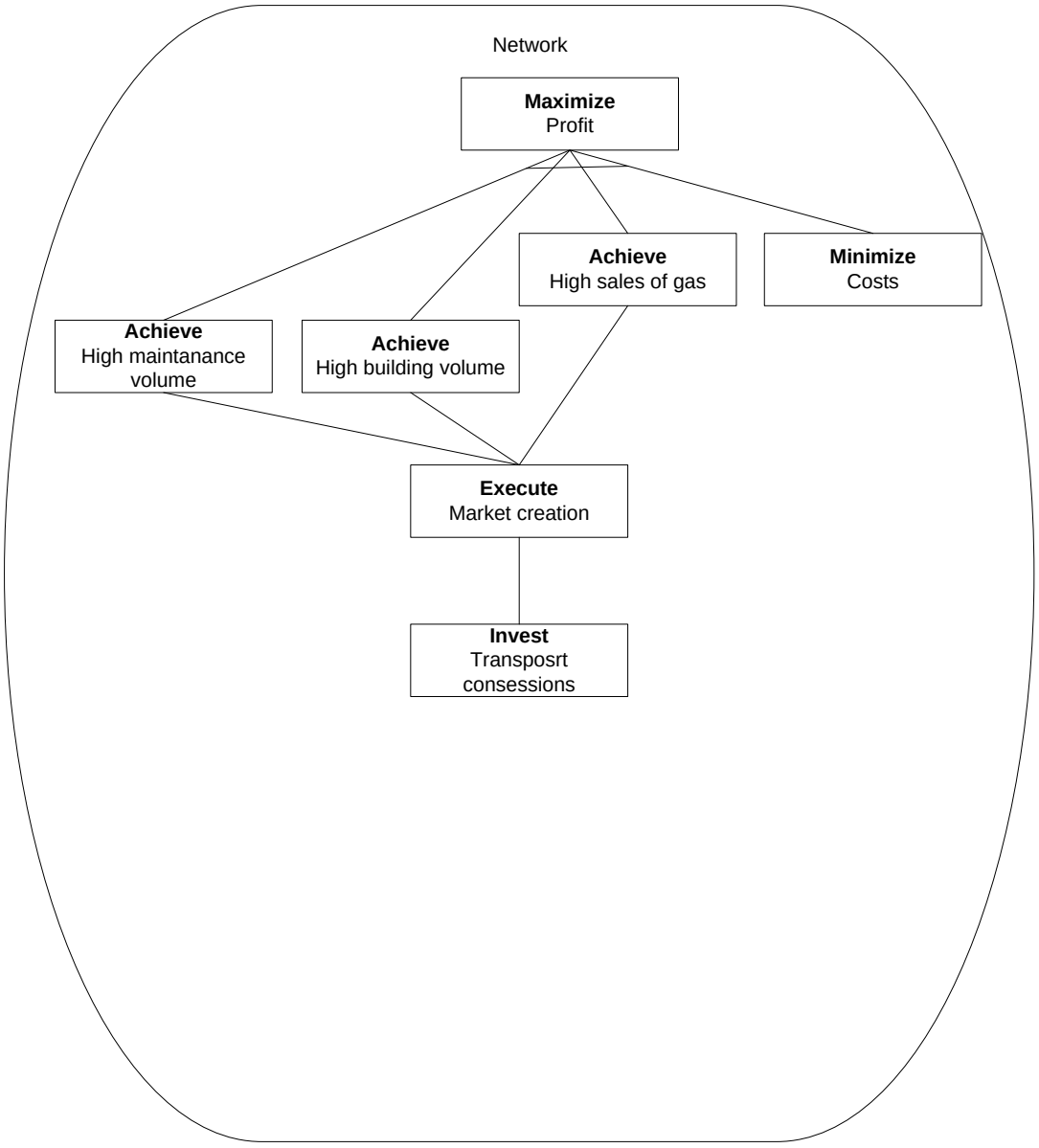
APPENDIX 2a
Actor goal models



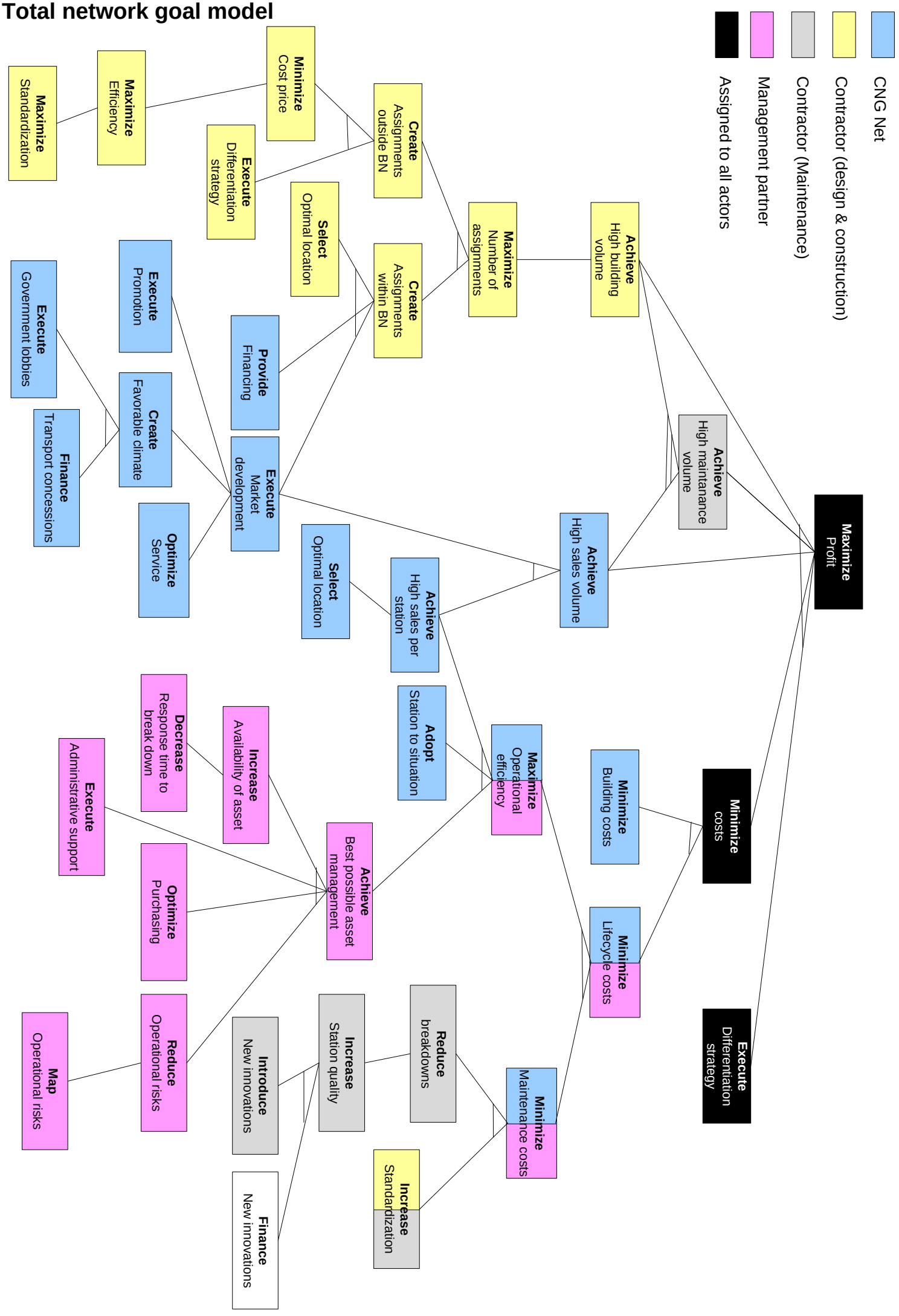

Management partner
Achieve
Best possible asset management
Increase
Availability of asset
Decrease
Operational costs
Decrease
Response time to break down
Optimize
Purchasing
Reduce
Operational risks
Execute
Administrative support
Map
Operational risks

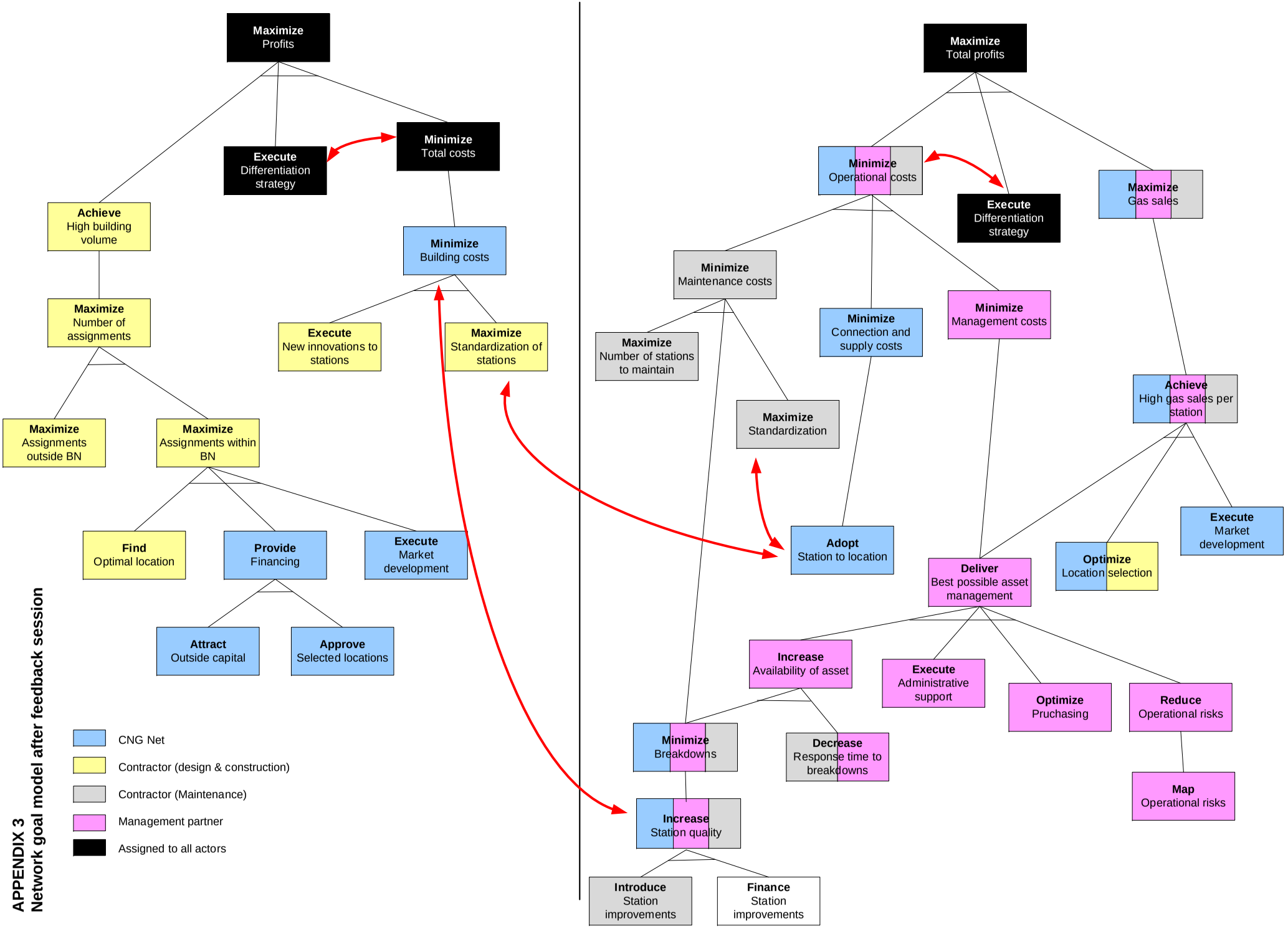

CNG Net
Maximize
Profit
Minimize
costs
Maximize
Gas sales volume
Decrease
Building expenses
Increase
Operational efficiency
Execute
Differentiation strategy
Achieve
High returns per
station
Optimize
Location selection
Execute
Market development
Execute
Promotion
Create
Favorable climate
Optimize
Service
Execute
Government lobbies
Finance
Transport concessions

APPENDIX 2b
Global network goal model



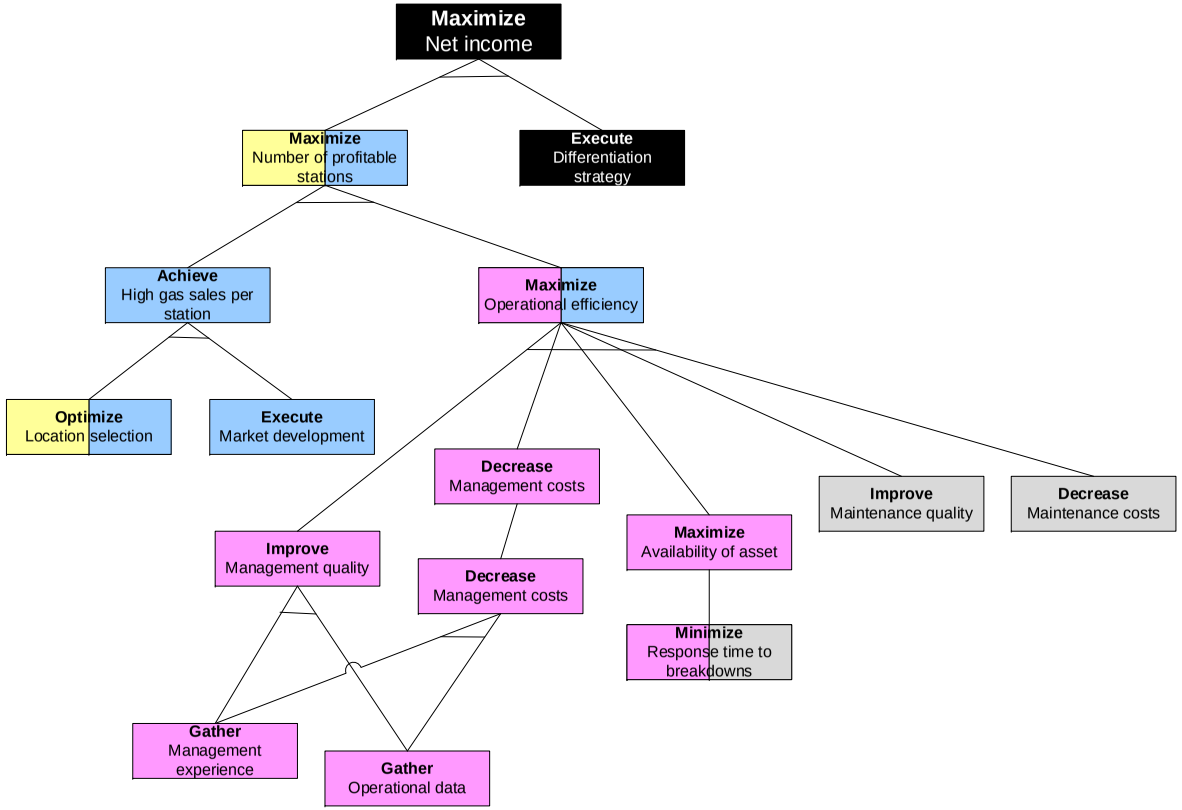
APPENDIX 2c
Total network goal model



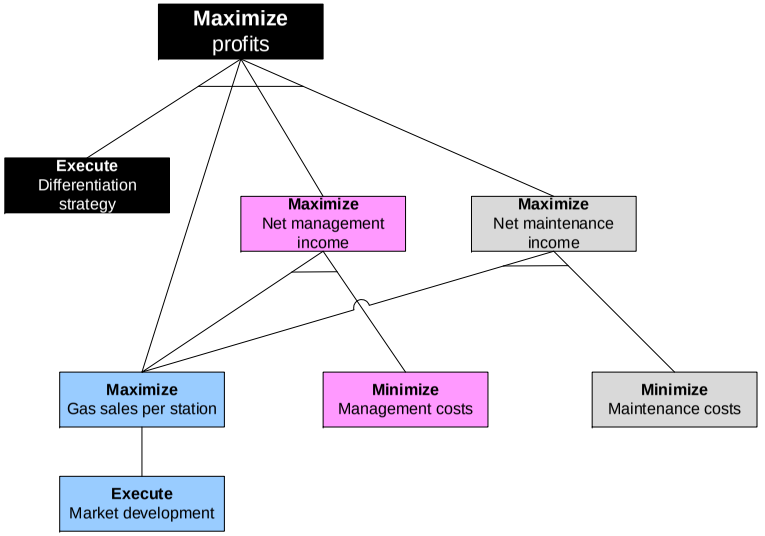


APPENDIX 3
Network goal model after feedback session

Short term goals



Long term goals



APPENDIX 4
Reference goal model

- CNG Net
- Contractor (design & construction)
- Contractor (Maintenance)
- Management partner
- Assigned to all actors

Appendix 5
E3-forces

Contractor -> Management

	Original	Edited	Beta	Multi
Supplier concentration	1	5	5	25
Necessity of value object	5	5	35	175
Importance of customer to supplier	4	2	10	20
Costs of changing supplier	3	3	35	105
Threat of take over by supplier	2	2	15	30
Strength				**71**

Energy supplier green -> Management

	Original	Edited	Beta	Multi
Supplier concentration	1	5	5	25
Necessity of value object	5	5	90	450
Importance of customer to supplier	3	3	3	9
Costs of changing supplier	2	2	2	4
Threat of take over by supplier	1	1	0	0
Strength				**97,6**

Energy supplier grey -> Management

	Original	Edited	Beta	Multi
Supplier concentration	5	1	5	5
Necessity of value object	5	5	90	450
Importance of customer to supplier	3	3	3	9
Costs of changing supplier	2	2	2	4
Threat of take over by supplier	1	1	0	0
Strength				**93,6**

Suppliers -> Contractor build

	Original	Edited	Beta	Multi
Supplier concentration	1	5	40	200
Necessity of value object	5	5	30	150
Importance of customer to supplier	5	1	10	10
Costs of changing supplier	5	5	10	50
Threat of take over by supplier	2	2	10	20
Strength				**86**

Contractor Build -> CNG Net

	Original	Edited	Beta	Multi
Supplier concentration	1	5	2	10
Necessity of value object	5	5	42	210
Importance of customer to supplier	5	1	42	42
Costs of changing supplier	1	1	12	12
Threat of take over by supplier	1	1	2	2
Strength				**55,2**

Suppliers -> Contractor maintenance

	Original	Edited	Beta	Multi
Supplier concentration	2	4	30	120
Necessity of value object	5	5	40	200
Importance of customer to supplier	3	3	20	60

Costs of changing supplier	4	4	10	40
Threat of take over by supplier	1	1	0	0
Strength				**84**

Energy suppliers green -> CNG Net

	Original	Edited	Beta	Multi
Supplier concentration	1	5	45	225
Necessity of value object	5	5	45	225
Importance of customer to supplier	5	1	10	10
Costs of changing supplier	1	1	0	0
Threat of take over by supplier	4	4	0	0
Strength				**92**

Energy suppliers grey -> CNG Net

	Original	Edited	Beta	Multi
Supplier concentration	5	1	45	45
Necessity of value object	5	5	45	225
Importance of customer to supplier	1	5	10	50
Costs of changing supplier	1	1	0	0
Threat of take over by supplier	4	4	0	0
Strength				**64**

Management -> CNG Net

	Original	Edited	Beta	Multi
Supplier concentration	1	5	20	100
Necessity of value object	2	2	40	80
Importance of customer to supplier	3	3	20	60
Costs of changing supplier	2	2	10	20
Threat of take over by supplier	1	1	10	10
Strength				**54**

Pump station -> CNG Net

	Original	Edited	Beta	Multi
Supplier concentration	2	4	20	80
Necessity of value object	4	4	40	160
Importance of customer to supplier	1	5	0	0
Costs of changing supplier	5	5	30	150
Threat of take over by supplier	4	4	10	40
Strength				**86**

CNG Net -> End user (free market)

	Original	Edited	Beta	Multi
Buyer concentration	2	4	30	120
Number of similar value objects	5	5	5	25
Alternative suppliers	2	2	5	10
Costs of changing supplier	1	5	10	50
Importance of value object	3	3	30	90
Low profits	4	2	20	40
Threat of take over by buyer	2	2	0	0
Strength				**67**

CNG Net -> End user (dedicated market)

	Original	Edited	Beta	Multi
Buyer concentration	2	4	30	120
Number of similar value objects	5	5	5	25
Alternative suppliers	2	2	5	10
Costs of changing supplier	5	1	10	10
Importance of value object	3	3	30	90
Low profits	4	2	20	40
Threat of take over by buyer	2	2	0	0
Strength				**59**

Management -> IPM

	Original	Edited	Beta	Multi
Buyer concentration	1	5	25	125
Number of similar value objects	1	1	0	0
Alternative suppliers	1	1	0	0
Costs of changing supplier	4	2	15	30
Importance of value object	3	3	35	105
Low profits	1	5	25	125
Threat of take over by buyer	1	1	0	0
Strength				**77**

Contractor Build -> CNG Net

	Original	Edited	Beta	Multi
Buyer concentration	2	4	30	120
Number of similar value objects	1	1	10	10
Alternative suppliers	2	2	30	60
Costs of changing supplier	5	1	10	10
Importance of value object	5	1	10	10
Low profits	3	3	5	15
Threat of take over by buyer	2	2	5	10
Strength				**47**

contractor maintenance -> CNG Net

	Original	Edited	Beta	Multi
Buyer concentration	2	4	10	40
Number of similar value objects	2	2	10	20
Alternative suppliers	2	2	0	0
Costs of changing supplier	4	2	0	0
Importance of value object	5	1	40	40

Low profits	1	5	40	200
Threat of take over by buyer	1	1	0	0
Strength				**60**

CNG Net -> Competition

	Original	Edited	Beta	Multi
Balance between competition	2	2	20	40
Low grow factor of the industry	2	4	20	80
High fixed costs	4	4	20	80
High exit barriers	4	4	20	80
Differentiation between competitors	2	4	10	40
Capacity augmented in large increments	2	2	10	20
Sacrificing profitability	2	2	0	0
Strength				**68**

Appendix 6

Paper by Tigchelaar, Radstok and Melis (2011)

Final Paper

Is Virtual Integration a suitable tool to improve the relationship quality between contractors and subcontractors in the construction industry?

Group 15

Gerben Tigchelaar (0667338)
Kris Radstok (0721962)
Stefan Melis (0721303)

Date: 3 June 2011

Abstract

Virtual Integration is one of the upcoming trends in collaboration, within various industries. This high involved way of collaboration with different partners can have a lot of advantages. Due to the financial crisis, the construction industry is in an uncomfortable position. In which a fierce competition has led to a decreasing number of jobs and profit margins. Next to that, the construction industry is characterized by a poor relational atmosphere, were price-chasing transactions and lack of trust are found to result in a confrontational and inefficient environment. It this research paper, it is analyzed if Virtual Integration would be a suitable tool for the construction industry. The focus of the research is on the relationship quality between partners in construction, because this is an important issue in both the construction industry and the concept Virtual Integration. In this paper three Dutch construction companies where investigated who are highly involved in a collaboration setting, which is similar to the theory of a virtual enterprise. Based in the literature and the findings in practice it is found that Virtual Integration would be a suitable tool for the construction industry to improve the relation quality and their position in the market. But it is recommended to evaluate the openness of the communication between partners frequently, because of the characteristics of the market.

1. Introduction

The construction industry is characterized by a high degree of collaborations between contractors and subcontractors. In these collaborations, large networks appear between contractors, subcontractors and suppliers. This industry is unfortunately characterized by a poor relational atmosphere as Gadde & Dubois (2010) call it. Short-term, price-chasing transactions and lack of trust are found to result in a confrontational atmosphere and working inefficiency in construction projects (Bresnen & Marshall, 2000) (Gadde & Dubois, 2010). It can be said that the collaborations in the construction industry are mainly based on costs, not the quality of the relationship. Relational quality would most likely improve work efficiency in the industry and though it should seem obvious to change the current situation, Akintoye et al (2000) claim that this way of collaborating is deeply rooted in the construction industry and that the industry is not very eager to change this.

One way to improve inefficiencies and relationship quality in partnership networks is by using Virtual Integration (VI). VI has become widely used in manufacturing over the past few decades. VI can be described as a form of networking, in which a very high degree of information sharing occurs between partners within the network. Network visibility, transparency and open information sharing are key principles in the so called Virtual Enterprise, which enhances supply chain integration and trust and reduce opportunism between network partners. These in turn, are also mentioned to be important measures of relationship quality (Naudé & Buttle, 2000) (Dwyer & Oh, 1987).

While VI is already widely used in manufacturing, there is no literature on virtual integration in the construction industry. This paper contributes to literature by looking at virtual integration in the construction industry. It can provide a practical contribution to management by providing insights into using VI in the construction industry. The main issues covered here are whether VI would be fit for the construction industry as it is for manufacturing and whether VI may be a suitable solution to improve the relational atmosphere in the construction industry. Also, would the construction industry be willing to adapt to a model like VI?

Therefore this paper will start from the main research question:

"Is Virtual Integration a suitable tool to improve the relationship quality between contractors and subcontractors in the construction industry?"

To answer this question, a set of sub questions must be answered first:

- What are the main aspects of VI?
- What are the main requirements for VI?
- Which factors enhance the quality and success of a relationship?
- What are the characteristics of the relation between contractors and subcontractors in the construction industry?

To answer these four sub questions, three areas in literature will be researched as shown in Figure 1: Virtual Integration, Relationship quality and Partnership in construction. The conclusions from this literature study should provide an answer to the main research question to the extent of whether VI will theoretically be suitable for the construction industry. Practical suitability should be examined by a field work study in the industry.

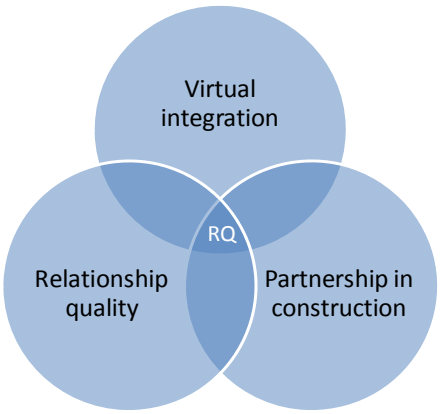


Figure 1 - Areas of literature study

2. Research design

2.1. Literature review methodology

This literature review is based on literature from the areas of Virtual Integration, Relationship quality and Partnering in construction. We first conducted a search through engines like ISI web of knowledge, Scopus, Emerald and Informaworld. Virtual Enterprises was also added as a search criterion since this is closely linked to Virtual Integration. Criteria used to judge the articles found where mainly the number of citations and the year of publishing. To obtain a thorough understanding and image of the up to date situation in the construction industry, we stuck to articles published over the past decade or at least not much older. The same accounted for Virtual Integration and Virtual Enterprises. We found relationship quality to be more of a psychological issue and less bound to time (though not completely unbound) and therefore loosened this criterion a little on this subject.

Finally, we also searched through the TU/e library and found two books published on Virtual Enterprises by Camarinha-Mathos and Afsarmanesh (1999) and Grefen and Mehandjiev (2010). These authors where already found during the online search, with a large number of publications and citations of their work.

2.2. Empirical research methodology

From the literature review a couple of issues rose that were found important in answering the research question. A framework, drawn up from the literature review, addresses these issues and will be used as a base for an empirical research to answer the research question. The empirical research consisted of a case study of a Dutch company in sustainable construction of homes. Around this initiating company, a network of consultants and sub contractors exists. The initiating company more or less functions as a contractor in this network.

This sub chapter discusses the methodology of the empirical research. In the first section, the population and the sample are discussed, followed

by the interview methodology in the second section.

2.2.1. Population and Sample

To obtain an accurate result from the case study, we used two different approaches for information gathering about the case. The first was a meeting with almost all parties involved in the construction network. This meeting was about how to organize the network and how to coordinate the processes. Our second method of information gathering was to conduct qualitative interviews with three of the key players in the network, including the central company, a consultancy firm and a large sub contractor. This selection of companies is made to gain insight in opinions from three different viewpoints in the network and obtain a broad range of information necessary to answer our research questions and investigate the issues from the integrated model. All of these companies where located in The Netherlands and have a long lasting experience in the construction industry. By this we mean that either the company, or the manager interviewed has at least more than ten years of experience in the industry. From each company we interviewed a manager who is personally assigned and involved in the studied project.

2.2.2. Interview methodology

The empirical research consisted of two parts. The first was an observation during a meeting of the involved partners. During this session, there was no active involvement of the researchers. This session merely provided insights into viewpoints of different network partners and the general situation in and around the network and its business. The results of this observation provided a sound base for the interviews, held during the second part of the empirical research.

Several interviewing methods are possible for doing research, but as we planned on qualitative research, personal interviews are most appropriate. Therefore we conducted individual and face-to-face interviews with the selected managers personally. The advantage of this way of personal interviewing is that one can obtain clear answers from respondents, as well as ask follow up questions regarding the given answers. Explanations can be obtained on unclear answers and new leads can be created from answers, creating new, possibly interesting insights. As with surveys, this is not possible.

Every interview started by introducing the research topic and an introduction of the company to be interviewed and their role in the network under research. After the introduction, the remainder of the interview was guided by a number of questions related to the issues from the integrated model. The guiding questions can be found in Appendix A. These open-ended questions are used to guide the interview into an open conversation with the respondent. This should provide a broad and complete range of information, which will serve either to confirm the findings from the literature review or provide discussion material

3. Literature review

3.1 Virtual Integration

Virtual integration is a form of networking in which the central key is a very high degree of open information sharing between the partners in the network. To share this information the partners make use of computer network supported platforms to link their information systems together. The business network these companies form is called a Virtual Enterprise (VE). There are several definitions of VEs found in literature. Davulcu & Kifer (1999) for instance describe a VE as *"a temporary consortium of autonomous, diverse and possibly geographically dispersed organizations that pool their resources to meet short-term objectives and exploit fast changing market trends"*. Camarinha-Matos & Afsarmanesh (2003) stay quite close to this definition by saying that a VE is *"a temporary alliance of enterprises that come together to share skills or core competencies and resources in order to better respond to business opportunities and whose cooperation is supported by computer networks"*. We can clearly distinguish three important recurring aspects in these definitions and therefore mention these as important characteristics of Virtual Enterprises. First the sharing of competencies and/or resources, secondly the

temporary character of the VE and thirdly the grouping of different enterprises into one consortium or alliance. Wang et al (2006) on the other hand provide a definition of Virtual Integration itself as "a strategy to reduce the influences of environmental uncertainty by improving inter-firm information processing, coordination and control". Combining these three definitions, we can say that VI and the formation of VEs can be seen as a practice to increase effective response to market and business opportunities, with the cooperation of multiple enterprises who share knowledge, skills and information by using IT supported networks.

As in these definitions, Wang et al *(2006)* state that VI can counter environmental uncertainty, but also often limits flexibility of the involved companies themselves because of interdependencies within the network. Because of the close collaboration, partners become more dependent on each other's performance and progress. On the other hand, it does increase the flexibility of the Virtual Enterprise as a whole. Wang et al. (2006) state that every subsystem in the supply chain within the VE has its own properties of flexibility and due to their autonomy, disturbances are kept local within the supply chain. This makes the supply chain as a whole less sensitive to environmental uncertainties (internal flexibility). External flexibility in its turn is created by the enhanced capacity of the network to influence the environment (for instance by economies of scale). VI enables companies to gain more control over the environment without having to exert ownership over its suppliers or partners. Wang et al (2006) add to this that companies can also increase environmental control by using VI, through the close collaboration with their suppliers. Because suppliers can gain better access to information about product and customer requirements, they can better respond to these requirements. Because suppliers meet customer requirements more thoroughly, this will reflect in the final product, making the whole value chain more responsive to the market.

Wang et al *(2006)* also mention another advantage, being that process oriented problems can be dealt with as well. These problems comprise for instance production stocks and throughput variance control. Production stocks for instance increase when sales decrease and over time, variances in sales will lead to variances in throughput (the bullwhip effect *(Lee, Padmanabhan, & Whang, 1997)*). By coordinating with buyers and obtaining and sharing information on demand patterns, inventory buffers and production capacity throughout the network, manufacturers can largely reduce these problems. By effectively coordinating and encouraging responsiveness among suppliers, manufacturers can also overcome operational problems like delay of orders, low quality, long lead times, etc. *(Wang, Tai, & Wei, 2006)*.

Despite the advantages mentioned by Wang et al. (2006) and although they recognize the same advantages, Bhimani & Ncube (2006) mention a number of risks and costs associated with VI. They divide risks involved in VE formation into three categories: Technical risks, business risks and application risks. This first category of risks includes all risks related to the technical formation of the VE and comprises aspects like the electronic linkage and transactions between companies. One can think for instance of the security aspects of data interchange. Bhimani & Ncube (2006) state that once a certain level of complexity is reached, the cost advantages will no longer compensate for the costs to set up and manage the VE. As linkages between and within industries become more extensive, the need for security, control and reliable data interchange increase as well, leading to an increase of necessary investments. The second risk category includes organizational choices for supplier integration and relates to trust between partners. There needs to be a certain degree of trust between the different partners to make the VE work in an efficient way. When partners distrust each other, efficient and proper exchange of information will suffer. The third risk category involves the assurance of the supply partners and relates to the business processes itself. In this category, Bhimani & Ncube (2006) point out risks concerning interdependencies between

partners within the network. When one partner within the VE fails, the VE, and therefore the single partners within, may fail as well.

Although Bhimani and Ncube (2006) mention the increase in costs related to VEs, Wang et al. (2006) argue that flexibility and cost reduction are two main competitive advantages of VI for manufacturers in highly uncertain environments. As they state, supply chain management manages two types of costs: Physical costs and market mediation costs. Physical costs comprise those costs related to manufacturing, transport and cycling stocks, i.e. costs related to the physical production and distribution of the product. Market mediation costs relate to costs of safety stocks and lost sales and therefore costs made to respond to the market (costs related to the before mentioned bullwhip effect). In highly uncertain environments, the market mediation costs mainly dominate over the physical costs and Virtual Integration is found to reduce the effects that cause the market mediation costs. These effects are mentioned above as the process related problems and accompanying bullwhip effect.

3.2. Requirements for Virtual Enterprise formation

Virtual Enterprises can be described as networks with a very high degree of information sharing and exchange among its members. To create the virtual enterprise, there is a certain need for information management, coordination and communication (Camarinha-Matos & Afsarmanesh, 1999). The prominent goal of the VE is to work together as a single integrated unit and to reach this, a Virtual Enterprise often, but not always, requires a coordinator to homogenize and control the performance of tasks by the members. Within a virtual enterprise different members may show different behaviors and responses towards the same type of event. Therefore, the coordination of the VE is required to be flexible. Besides, this coordinator should have privileged access to local data of the enterprise. The delay of one node in the virtual enterprise may jeopardize the entire process of the VE, mentioned before as the interdependency between members of the VE. Therefore, one member may take the role of coordinator and manage the interdependencies among various processes (Camarinha-Matos & Afsarmanesh, 1999).

Configuration of the environment of the VE, the IT infrastructure located at each member of the VE and the levels of autonomy and privacy within the VE are found closely related requirements for a flexible coordination system by Camarinha Matos & Afsarmanesh (1999). Mehandjiev and Grefen (2010) also mention three necessary requirements for VE formation, being: (1) contracts, (2) enactment and (3) visibility. Contracts form a base of shared understanding and agreements. Enactment is used as a tool to coordinate work. Visibility, at last, supports decision making and participation between different partners. In other words, there is a need to clearly agree on the business, shares, rules and performance and these should be clear and visible to all partners, as well as the pursuance of them by the different partners (Grefen & Mehandjiev, 2010).

Communication and information sharing is one of the key aspects of Virtual Enterprises. To ensure effective and efficient execution of this aspect, there are certain requirements bound to as well. A key requirement for the communication between different members of the VE and their information systems is that there is a uniform and consistent information access and management. This should in the mean while come with a certain degree of privacy to ensure secure information exchange between the members (Camarinha-Matos & Afsarmanesh, 1999). Davulcu et al. (1999) add to this the need for a universal language to specify structures, processes and actions between different entities. They also state the need for several core technologies to create and operate virtual enterprises, like network technologies and standards for interoperability. Grefen & Mehandjiev (2010) relate to these requirements as the need for an interoperational platform between the members of the VE. By this, they mean that there should be an IT platform to which the different information systems of members can be

linked and through which they can communicate and exchange information.

3.3. Relationship quality

Successful management of business relationships is an issue of debate among practitioners and academics. Improving the relationship quality is clearly an important issue in this field of research and management. A relationship can be described as a bond between two parties (Berry, 1995). The quality of relationships was possibly first described by Dwyer & Oh (1987), who indicated high levels of satisfaction, trust, and minimal opportunism as facets of relationship quality. This is partly confirmed by Crosby *et al*. (1990) who state that relationship quality is a two dimensional construct made of satisfaction and trust.

Research performed by Naudé et al. (2000) and Roberts et al. (2003) determined the dimensions of relationship quality with an extensive literature review from a marketing perspective. Their results are partly similar to those of Crosby et al. (1990) and Dwyer & Oh (1987) in the sense that they also distinguish trust and satisfaction as dimensions for relationship quality. Naudé et al (2000) nonetheless, add supply chain integration, power and profit to these dimensions. Roberts et al. (2003) came up with commitment and affective conflict as additional dimensions. The difference between the dimensions distinguished by these two groups of authors can be explained by Naudé et al. (2000) focusing merely on business-to-business relationships, while Roberts et al. (2003) look at a broader perspective. Because of their business-to-business focus, we can therefore assume that the dimensions of Naudé et al. (2000) are more appropriate for our research on the relation between contractors and subcontractors.

Despite the findings of these dimensions of relationship quality, they are not always found equally important. Ashnai et al. (2009) investigated which dimensions of relationship quality were found most important in different cultural environments. They used the five dimensions of Naudé et al (2000) to investigate differences in how important these dimensions were found to be by managers from different developing and developed economic areas. These areas where the U.K., Russia, Iran and China. They found that though profit was very important to the mangers from the three economically developing areas (Russia, China and Iran), managers from the economically developed area (U.K.) did not put a high value on profit. These managers valued trust as the most important dimension of relationship quality.

Naudé et al. (2000) analyzed the five dimensions as well with a sample-group of 40 middle to senior executives, in order to distinguish successful relationships. There seemed to be no single explanation of this construct: rather, there are different views of what determines a good relationship, and managers need to take this into account in effectively managing their supply chain relationships. Although based on a relatively small sample, it does appear that the determinants of relationship quality are contingent upon wider contextual factors. As trust and mutual satisfaction of needs seem to be the most important and most often recurring dimensions, these are clearly not the only and not by definition the most important dimensions.

3.4. Partnering in the construction industry

Subcontractors are playing an increasingly important role in construction projects. The result of this increased involvement is that main contractors are now concentrating their efforts on managing subcontractors rather than employing direct labor (Matthews, Pellew, Phua, & Rowlinson, 2000). This means that the relations between contractors and sub contractors have become increasingly important. Unfortunately, the construction industry has been described throughout literature as being characterized by a poor relational atmosphere (Gadde & Dubois, 2010). Short-term, price-chasing transactions and lack of trust are found to result in a confrontational atmosphere and work inefficiency in construction projects (Bresnen & Marshall, 2000) (Gadde & Dubois, 2010). Gadde & Dubois (2010) explain this confrontational atmosphere as part of a

mixture between collaboration and confrontation, which together make up the relationship atmosphere between two parties. Collaboration contains features such as trust and commitment, whereas confrontation contains those like power and conflict. Collaboration aspects help to overcome relationship tensions, often caused by the confrontational aspects.

The confrontational atmosphere can, according to Bresnen & Marshall (2000), be drawn back to the fact that many relationships in the construction industry are traditionally based on deep-rooted cost driven agendas, resulting in inefficient business processes. Others, like Gadde & Dubois (2010) and Naoum (2003) indicate that the poor efficiency and performance in construction originate from failure of "traditional procurement methods" (Naoum, 2003). These "traditional procurement methods" mainly rely on contractually explicit procedures rather than on mutually agreed methods to achieve financially sound objectives for the entire team. According to Thompson et al. (1998) the construction industry assumes that economic efficiency can be obtained through competitive tendering procedures, where little attention is paid to the relational elements of a business transaction. These numerous indications lead to the assumption that relationships in the construction industry and therefore also between contractors and subcontractors are mainly focused on costs and less on relational elements.

A claim made my Gadde & Dubois argues that the inefficiencies in the construction industry mainly occur from the often short-term and price-chasing business transactions. Akintoye et al. (2000) conducted a research on the agreements and relations between contractors and their suppliers that confirms the short-term characteristic and the lack of focus on the relationship quality. The research shows that only 40% of all agreements were made for a period longer than 2 years , indicating that most of the contracts are rather short term agreements. Another important finding of Akintoye et al. (2000) is that contractors rather look upstream in the supply chain than downstream. 67,5% of their responding contractors valued their client relation as more or equal to that with their suppliers. These results question the willingness of the contractors to build a sustainable and high quality relationship with its suppliers, including subcontractors.

This willingness to change this situation is off course an important issue when improving the relational atmosphere in the construction industry. The Construction Industry Institute (CII) concluded that successful restructuring requires *"changing traditional relationships to a shared culture without regard to organizational boundaries''* (Gadde & Dubois, 2010). This means that partners should focus less on costs and more on trust, interests and creating a win-win attitude in their partnerships. Nonetheless, according to Akintoye et al. (2000), the present way of collaborating is deeply rooted in the construction industry and the industry is not very eager to change this. According to Gadde & Dubois (2010), firms in the construction industry avoid close and intensive cooperation with business partners to remain technically independent. Gadde & Dubois (2010) also state that subcontractors often find that they become vulnerable for "bullying" by main contractors when they engage in long strategic alliances with them. They need to be convinced that partnering can improve their chances of survival.

There have been attempts to improve the quality of the relational atmosphere in the construction industry. Unfortunately, adopting Supply Chain Management (SCM) as a management strategy in the construction industry turned out to result in little progress. This was found to be due to the price orientated and low-involvement characteristics of the industry (Akintoye, McIntosh, & Fitzgerald, 2000). Nevertheless, the management technique of partnering does receive a lot of attention in the construction industry and is referred to as *"the most significant development today as a means of improving performance"* (Wood & Ellis, 2005). It's defined by the CII as:

"A long term commitment between two or more organizations for the purposes of achieving

specific business objectives by maximizing the effectiveness of each participant's resources. This requires changing traditional relationships to a shared culture without regard to organizational boundaries. The relationship is based on trust, dedication to common goals and an understanding of each other's individual expectations and values." (Gadde & Dubois, 2010)

The implementation of partnering requires an enormous change in the traditional way of working and needs collaboration of both parties. However, organizations in the construction industry that apply partnering still apply it on projects and short term agreements (Gadde & Dubois, 2010). This is caused by the fact that the majority of construction projects are one-off, which often means that no long-term business relationships can be established (Gadde & Dubois, 2010). It also implies that organizations in the construction industry often have trouble developing a shared culture over multiple projects. Despite the effort to change the culture in the construction industry, research by Wood & Ellis (2005, p. 318) revealed that ''Typical contractor / subcontractor relationships are still cost-driven and potentially adversarial''.

4. Integrated model

From the literature review we can come to several conclusions. To start with the construction industry, it seems that although relations between contractors and subcontractors have become increasingly important. Despite their importance, these relationships are often characterized by a highly confrontational atmosphere and poor efficiency. This can, according to some authors, be related to their cost-driven and short-term character. Competitive tendering procedures are often seen as a means to obtain economic efficiency, leading to a focus on costs instead of relational elements. Another important finding is that main contractors don't seem to value their relationship with their suppliers and/or subcontractors, who in their turn are anxious to engage in long strategic alliances with main contractors. Although there have been attempts to change the relational atmosphere in the construction industry, it seems that the deep rooted way of collaborating is hard to change.

Although it is hard to define dimensions for good quality relationships, it seems that trust and mutual satisfaction between partners are the most important and often recurring dimensions from research. Other dimensions that come forward multiple times are integration of supply chains, power and profit. Nonetheless, as stated by Ashnai et al (2009) and Naudé et al (2000), not all of these dimensions are always valued equally important and that this is also dependent on wider contextual factors.

Virtual Integration, finally, creates a network of businesses with a very high degree of information sharing, openness and performance visibility. This so called Virtual Enterprise is often more responsive to market developments and can obtain a high flexibility and efficiency as a whole network. The open information sharing is likely to result in higher degrees of trust between the different partners in the network. The downside is, however, that members in a VE can also become increasingly dependent on each other. Something that's mentioned in the construction industry as an argument not to engage in long lasting and intense relationships. The formation of a VE off course requires that the different participants are willing and able to connect their information systems and exchange information on amongst others their actions, products and performance. Secondly, there should be one partner, who is able to take the role of coordinator and who is also recognized for this position by the other members.

Theoretically, it seems that VI may be suitable for the construction industry in the sense that it is suitable to improve relationship quality and works very well for short-term as well as for long-term relationships. So VI can enable the construction industry increasing its relational atmosphere, while still enabling short-term agreements. On the other hand, effort needs to be put into changing the industry from a cost based focus, to a focus on relational quality. The main problem is still that the

construction industry needs to be willing to change its ways.

This last point immediately links to the first of four issues rising from the literature review according to the suitability of VI. These four issues form the framework for the empirical research (Figure 2).

The first point is whether there is any willingness in the construction industry to change the way of cooperating, or is the industry not by any means willing and capable to adapt. When there is no willingness to engage in a high degree of information sharing, the introduction of VI is pointless. The same accounts for the ability of companies in the industry to share information and link information systems. On top of that, it is not always clear what the important factors of relationship quality are. It should be made clear which dimensions of relationship quality are valued high by companies in the construction industry and whether these dimensions are promoted by VI. If certain dimensions are not valued at all, one can ask if it makes sense to try to improve these dimensions. Finally, there should be a coordinator in the VE. The fourth issue comprises the possibility to assign such a coordinator and determine its characteristics and position in the network.

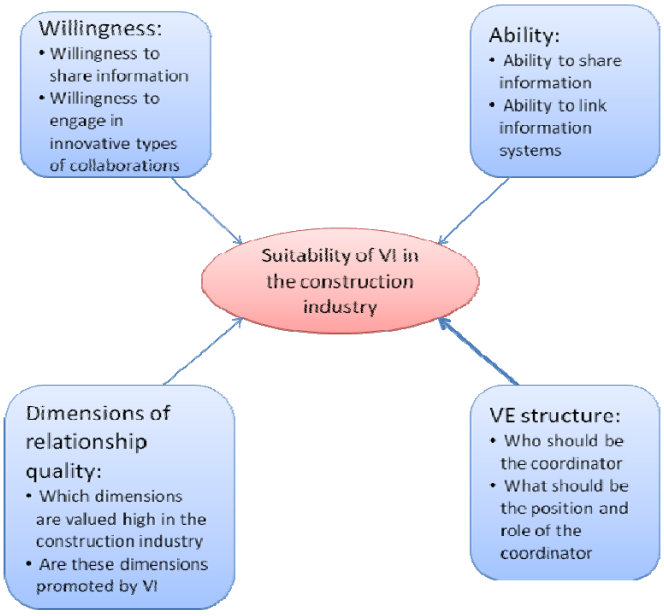


Figure 2 - Framework for the empirical research

5. Emperical research

To investigate the issues of the integrated model, a case study of a collaboration network around a Dutch company in sustainable construction of homes has been conducted. In this chapter the findings on each of the four issues form the integrated model are presented.

5.1. Willingness

Earlier in this paper it is mentioned that theoretically, VI may be suitable for the construction industry. Nonetheless, the main problem remains that the construction industry needs to be willing and able to change its ways of collaboration. When organizations lack the willingness to participate in a Virtual Enterprise, the introduction of VI is pointless. As shown in the integrated model, we can look at two different points regarding willingness to adopt.

The first issue is the willingness to involve in an innovative or new way of collaboration. All respondents made clear that they would personally be willing to engage in such innovations. On a company level, there was a certain acknowledgement that this was also the case. It was nonetheless mentioned by all of the interviewed managers that this would likely not be the case for the entire industry. Despite, they all agreed that there is a shift towards innovation in the industry, resulting from the financial crisis. Due to the financial crisis, the amount of residential building projects has been reduced by approximately 50% over the past two years. This resulted in a fierce competition within the industry. Therefore, companies are increasingly willing to look for alternative ways to create income and employment for their workers enhancing innovation in construction projects. Also during the observed meeting, the present parties acknowledge that their involvement comes from a need to look for new and innovative ways to create work and projects. Two of the three interviewed managers indicate that they or their company is already involved in Virtual Integration type of networks.

The second point is that companies should be willing to share information on their performance,

progress and finance. Again, there is a general consensus amongst the involved parties, that they are willing to share information with each other. Above all, all parties make mention of the use of BIM systems (Building Information Model). By using a BIM, the CAD and eventually CAM systems of the network partners can be coupled , enabling them to see what other partners do. Throughout the interviews and the observed meeting, it seems that all parties either already work with these kinds of systems, or are willing to adopt it.

Sharing of financial information through the network seemed to be a little more delicate. To obtain an open relationship and determine costs and prices of projects and products, it is important that individual partners provide insights into their budget. According to the initiating company, this is one of the most important factors in open collaboration between them and their partners. One argument in favor of open budgets is that it enhances trust amongst partners. The respondents were also willing to take this step, although in one interview a more reticent position was observed. One remarkable observation was the difference in opinion between the respondents on the extent to which budgetary openness was already present in the network. This could also be linked to a long discussion during the meeting of the partners about price determination.

Also with regard to general information sharing and coupling of information systems, all three respondents provide different opinions to the level of openness and sharing of information throughout the network. Although one of the respondents implies that there is an optimal and complete transparency and linkage throughout the network, the other two respondents are more cautious on this topic, but also not both to the same extend. There doesn't seem to be consensus on the current situation with regard to this topic among the respondents.

5.2. Ability

Companies in the construction industry should not only be willing, but also be able to participate in a VE structures. This implies that companies should, amongst others, have the ability to share information and link information system.

One interviewee mentioned that it's important to have a shared IT platform through which general information and technical expertise is shared among partners. This was supported by another respondent, who added that this shared platform should enable 3D designing. 3D designing had proven to be an important innovation in other cases where partners worked together simultaneously on the same design by coupling their CAD systems through an IT platform. This way of working enabled each party to see what other parties did and adapt their own work to each other's.

Despite possibilities, one of the respondents mentions a challenge. Though integration of CAD systems already takes place, the integration of CAM systems is not enabled yet and according to the respondent, this is going to be much harder to realize. Nonetheless, according to a second respondent, integration of CAM systems is already possible and can easily be enabled.

Although it seems that for the larger part companies are already technically able to connect their information systems this does not automatically mean that the involved parties are able to share information. In the previous sub chapter, all respondents and involved parties showed clear willingness to share information and provide insights into their budgets. This is, however, partly based on personal willingness. As one of the respondents indicated, he could not confirm this willingness to share information for his upper management. Disapproval by upper management could disable him to share certain information, despite his own willingness.

5.3. Dimensions of relationship quality

There are several dimensions mentioned in literature that are found to be important for relationship quality. These where however not always valued equally important by companies (Ashnai, Smirnova, Kouchtch, Yu, Barnes, & Naudé, 2009) (Naudé & Buttle, 2000).

It’s important to gain insights into which dimensions of relationship quality are valued high by companies in the construction industry and whether these dimensions are promoted by VI. If certain dimensions are not valued at all, one can argue whether makes sense to improve these dimensions.

All three interviewees expressed that, looking at the construction industry as a whole, the overall tendency in relationships is cost based. They also mention that the industry is rather conservative regarding relationships. Nonetheless, two of the respondents also mention that there is also a number of more innovative and progressive firms in the industry.

All three respondents indicate that they value trust as the most important dimension of a relationship. Secondly, they certainly recognize and value the advantage of supply chain integration. Despite that they all state that trust is the utmost important dimension, profit is finally the dimension that keeps them in business. Therefore, trust and supply chain integration are valued high, as long as ample profits are made. Mutual satisfaction was especially emphasized by the initiating company. Power has not been valued as an important dimension by any of the respondents.

The interviewees agree that the high valued dimensions can lead to various valuable advantages. Longer and better relationships, based on trust, can create better communication and coordination of work between partners in a network. Secondly, it can result in cost reduction, starting by improving the efficiency during the design phase, since miscommunication and failure costs will be diminished. Integration of supply chains results in better cooperation and reduction of flaws in the final construction. They also recognize that relations built on trust often result in more projects and tenders.

One of the respondents recognized that although the industry moves, in a general sense, more towards trust-based relationships, costs and profits often still undermine this dimension, making it hard to build up long lasting, trustful relationships.

One respondent mentioned that the short term, cost driven relationships will lead to multiple disadvantages. One of them is increased uncertainty, since it is not known what quality can be expected from suppliers or sub contractors. Besides, these short term related organizations often hardly think along in the processes of the initiator. The respondent concluded that also in the construction industry, costs often determine the quality of product.

5.4. VE structure

One of the requirements for a VE mentioned in the literature is the recommended assigning of a coordinator. This topic has also been discussed during the interviews and was broadly discussed during the meeting between the network partners.

We found consensus between all partners that there is a obvious need for a coordinator within the network. However, regarding the position and characteristics of this coordinator we found some differences in opinions.

On one hand, the initiating company pleas for a coordinator who is on the same hierarchical level as the other members of the VE, which improves shared bounds. The coordinator should hold an overview of all the processes and parties involved and is responsible for securing and saving knowledge during the process and maintain stability throughout the network.

The other respondents, however, indicate that the coordinator should be hierarchically above the other partners. The coordinator should posses commercial knowledge and more important, knowledge on construction processes. When the latter lacks, the coordinator should have a more delegating function according to some of the partners. Another opted solution is that coordination responsibilities are divided between a commercial coordinator and a technical coordinator. Possible coordinators mentioned are the initiating company, together with a more technical grounded partner, such as the architect

who is found to bare more risk and contributions than most of the other parties. Another option, mentioned during the meeting is to assign an external coordinator. By the time this report was written, the initiating company had assigned one of the consultancy partners as coordinator.

6. Conclusion

From the literature review, four issues were raised that were found important to answer the research question. Empirical research was conducted to investigate these issues. In this section conclusions will be drawn from the literature review and the empirical research.

6.1. Willingness

In the literature review, the issue is raised whether the construction industry is willing to change their ways of collaboration. There was also stated that, one of the requirements of VI is a high degree of information sharing amongst network partners. From the empirical research, we can conclude that the willingness to engage in innovative partnerships is growing in the construction industry. One of the motivators to change is the financial crisis, which caused a decrease in jobs and an increase in competition throughout the industry. Companies within the construction industry tend to see an opportunity to be more competitive if they can lower supply chain costs by more efficient collaborations. The interviewed managers all saw the importance of sharing information within a partnership, however they have different ideas about the content of the information and the extent of sharing. The willingness to share specific amounts of information, such as knowledge and financial data, is still based on trust between partners.

One remarkable observation during the empirical research was that there is some sort of bystander effect amongst the partners in the case study. All partners are willing to change and adopt, but seem to wait for the others to go first. We could not find the exact reason for this, but may have to do with deep rooted distrust within the industry or some anxiety to change.

6.2. Ability

Apart from willingness of companies to share information and engage in VEs, companies also need to be able to do so. Literature suggests a rather conservative attitude throughout the construction industry. Despite this statement, the empirical research discussed in this paper showed that there is a shift to adoption of ICT. Nowadays the industry is developing software to enable the connection of information systems of different construction companies to share information and work coherently on designs. This ability is a requirement for Virtual Enterprise formation. A major impact came from the use of 3D-designing, by which different companies can work simultaneously on the same digital 3D design. Despite the innovative developments in ICT, it was confirmed during the empirical research that the construction industry is still lagging behind on other industries, like manufacturing. As a conclusion to our research, the ability to share information and connect information systems is present, though there is still much room for improvement and progress.

6.3. Dimensions of Relationship quality

From the five dimensions of relationship quality mentioned in the literature research, four were valued by the interviewed companies. Trust was by far the most important dimension according to the interviewees. We can conclude from the empirical research that there is definitely awareness in the construction industry of the importance of trust-based relationships instead of cost-based relationships. Supply chain integration, mutual satisfaction and profit where also valued, opposed to power, which was not valued by any of the respondents. All of these valued dimensions can be directly or indirectly related to VI. Trust is enhanced by the openness of information sharing. Supply chain integration is enabled by the close collaboration within a VE, as is, indirectly, mutual satisfaction. Profit is indirectly generated through cost savings due to more efficient collaboration.

6.4. VE-Structure

From the literature review we can conclude that it is recommended to assign one of the partners the

function of coordinator. From the empirical research we can confirm the need for a coordinator in building projects. Normally, this role is assigned to the main contractor. Our respondents indicated that the coordinator should posses commercial and above all, technical knowhow. Added to that, the coordinator should be able to overview processes and partners in the network and secure stability and knowledge in the network. Since the majority of respondents agreed that the coordinator should be hierarchically above the other partners, we think this should be seriously considered within networks.

6.5. Research question

After analyzing the issues from the integrated model, it can be concluded that VI can be applied in practice in the construction industry. Although it is thought not to be throughout the entire construction industry, the willingness and ability to engage in VI was found present in the case study. We can therefore conclude that slowly, the construction industry may be shifting towards more innovative partnering. There is a clear need for a coordinator, but this is also accepted by all parties and valued dimensions of relationship quality are supported by VI. This means that VI can certainly be a suitable tool for improving relationship quality in the construction industry. In our case study, it was even more certainly found that VI can be a very useful tool.

6.6. Scientific contribution

In this research, it is proven by a case study that VI can also be practiced in the construction industry. As far as we know, this was not yet to be found in scientific literature. Besides, scientific literature mentioned that contractors and subcontractors are mainly focused on costs and less on relational elements. Though it was pointed out during our empirical research that the majority or the industry still works that way, our case study shows that the industry is changing.. Apparently, recent developments in the construction industry due to the financial crisis might have resulted in a different value perspective of organizations.

6.7. Managerial Implications

Virtual Integration is an upcoming tool adopted in different kinds of industries, mainly in manufacturing. However, the construction industry seems to lag behind on this issue. Nonetheless, there is a growing need in the construction industry to be more innovative in partnering and creating leads for projects. From our research it is concluded that Virtual Integration could be applied in the construction industry. For successful implementation of VI it is important to promote openness and clarity amongst network partners. To get and maintain all partners on the same level and reach consensus regarding information sharing, openness and coordination, we advise to regularly check with all partners together whether they all perceive these aspects the in the same way. Especially during the creation phase of the VE, this can be very important to enhance trust and counter dissatisfaction amongst partners. Another important issue is to break the bystander effect. It seems that partners are all willing to engage or take action, but wait for the others, who in turn, wait for them, creating a vicious circle. The coordinator of the VE should try to break through this vicious circle.

6.8. Limitations

First of all the there are a few limitations due to the tight time schedule. For this research, we used one case study and interviewed only three different parties. This is a rather small sample of companies and a larger sample might result into better validity of the results. Also the companies involved in the research were all Dutch, which makes the research orientated on the Dutch construction industry. Next to that, our case study company was already focusing on a virtually integrated way of networking. It might have been better to (also) investigate a company which doesn’t focus on this way of networking yet. Finally, the investigated network did not deliver any project yet. Only the set-up of the network is defined. Therefore it is not clear whether VI is successful for collaborations in the construction industry, only that it can be used as a tool.

6.9. Future research

For future research it would be interesting to evaluate if Virtual Integration is suitable for less innovative organizations in the construction industry than the those in the network studied. Next to that, the investigated network did not delivered a project yet, so future research can be conducted on the results of VI. Finally, more thorough research could be done on this subject, including more cases and respondents.

References

Akintoye, A., McIntosh, G., & Fitzgerald, E. (2000). A survey of supply chain collaboration and management in the UK construction industry. *European Journal of Purchasing & Supply Management 6* , 159-168.

Ashnai, B., Smirnova, M., Kouchtch, S., Yu, Q., Barnes, B., & Naudé, P. (2009). Assessing relationship quality in four business-to-business markets. *Marketing Intelligence & Planning* , Vol. 27 No. 1, 2009, pp. 86-102.

Berry, L. (1995). Relationship marketing of services - growing interest, emerging perspectives. *Journal of Academy of Marketing Services* , Vol. 23 No. 4, pp. 236-245.

Bhimani, A., & Ncube, M. (2006). Virtual integration costs and the limits of supply chain scalability. *Journal of accounting and public policy* , 390-408.

Bresnen, M., & Marshall, N. (2000). Partnering in construction: a critical review of issues, problems and dilemmas. *Construction Management and Economics 18* , 229-237.

Camarinha-Matos, L. M., & Afsarmanesh, H. (2003). Elements of a Base VE Infrastructure. *Computers in Industry* , 139-163.

Camarinha-Matos, L. M., & Afsarmanesh, H. (1999). *Infrastructuresfor Virtual Enterprises.* Norwell, Massachusetts: Kluwer Academic Publishers.

Crosby, L. A., Evans, K. R., & and Cowles, D. (1990). Relationship Quality in Services Selling: An Interpersonal Influence Perspective. *Journal of Marketing* , 54, July, 68–81.

Davulcu, H., & Kifer, M. P. (1999). Modeling and Analysis of Interactions in Virtual Enterprises. *Information Technology for Virtual Enterprises* (pp. 12-18). Sydney, australia: Proceedings of the Ninth International Workshop on Research Issues on Data Engineering.

Dwyer, F., & Oh, S. (1987). Output sector munificence effects on the internal political economy of marketing channels. *Journal of Marketing Research* , Vol. 24, pp. 347-358.

Gadde, L.-E., & Dubois, A. (2010). Partnering in the construction industry - Problems and opportunities. *Journal of Purchasing & Supply Management (16)* , 254-263.

Grefen, P., & Mehandjiev, N. (2010). *Dynamic Business Process Formation for Instant Virtual Enterprises.* London: Springer.

Lee, H., Padmanabhan, V., & Whang, S. (1997). Information distortion in a supply chain: The bullwhip effect. *Management Science* , 546-558.

Matthews, J., Pellew, L., Phua, F., & Rowlinson, S. (2000). Quality relationships: partnering in the construction supply chain. *International Journal of Quality & Reliability Management* , Vol. 17 Nos 4/5, 2000, pp. 493-510.

Naoum, S. (2003). An overview into the concept of partnering. *International Journal of Project Management* , 71-76.

Naudé, P., & Buttle, F. (2000). Assessing Relationship Quality. *Industrial Marketing Management* , 29, 351–361.

Roberts, K., Varki, S., & Brodie, R. (2003). Measuring the quality of relationships in consumer services: an empirical study. *European Journal of Marketing* , Vol. 37 No. 1/2, 2003, pp. 169,196.

Thompson, I., Cox, A., & Anderson, L. (1998). Contracting strategies for the project environment. *European Journal of Purchasing and Supply Management 4* , 31-41.

Wang, E., Tai, J., & Wei, H. (2006). A virtual integration theory of improved supply-chain performance. *Journal of management information systems* , 41-46.

Wood, G., & Ellis, R. (2005). Main contractor experiences of partnering relationships on UK construction projects. *Construction Management and Economics 23* , 317-325.

Appendix A

The following questions where used a lead to guide through the conducted interviews.

- Would a structure, in which multiple partners working together on one project closely share information and in such a way increase performance, flexibility and responsiveness, appeal to you? Why (not)?
- To what extend would your organization be willing to share information and give insights into performance. Why (not)?
- To what extend is your company able to engage in close, virtual, information sharing? Why (not)? If not, what should be needed to enable this?
- What are the interests of the organization to engage in partnerships? Why?
- How can the duration of a relationship be described? What does this mean for the relationship between the companies?
- Which factors in relationships are of importance to the company and why?
    - Levels of trust
    - Mutual satisfaction
    - Profit / costs
    - Integration of supply chains
    - Power
- In a VE structure, who should in your opinion be the coordinator and why?

Appendix 7

Excel sheets of value model

This appendix is not included due to confidentiality.