Power-leveling as an effect of group model building.

L.P.J. van Nistelrooij, E.A.J.A. Rouwette, I.M. Verstijnen, J.A.M. Vennix,

Institute for Management Research, Radboud University Nijmegen

P.O. Box 9108, 6500 HK, Nijmegen, The Netherlands

Telephone: +31 (24) 361 55 78, Facsimile: +31 (24) 361 19 33

E-mail: b.vannistelrooij@fm.ru.nl

Abstract

The influence of power is a relatively unexplored area within group model building assessment studies. In this paper we explore the effect of group model building on the use of power by participants in modeling sessions, by applying social exchange theory to the communicative exchange process. According to this theory, differences in power between two participants influence their behavior: the larger the power differences between the two participants the less likely they are to interact and vice versa. In general, this behavior is not helpful in designing optimal solutions. It is hypothesized that group model building helps to reduce the use of power by participants compered to regular meetings, we refer to this effect as power-leveling. If our assumption holds, this may explain why group model building is helpful in designing better solutions. This research is conducted in a field setting at the Dutch Health Care Insurance Board, where regular meetings and group model building meetings are studied. The results indicate that the assumption of power-leveling as an effect of group model building seems to hold. Further research is however required to strengthen these findings.

Key words: group model building, social exchange theory, power, exchange, power-leveling

Introduction

Social systems such as the Dutch healthcare system are highly dynamic and complex (Homer & Hirsch, 2006). People in general are limited in their ability to process information about the current and future behavior of such systems (Simon, 1991). Hence, decision-makers are also faced with these limitations when they have to reach a decision on changes in these complex systems. System dynamics overcomes these limitations by supporting the decision-making process through the application of simulation techniques. The creation of a simulation model generates insights into the structure of cause and effect relations within the system. Additional insights into the relation between the behavior and the causal structure of the system are obtained from computer simulations with this model (Sterman, 1994). These insights improve the line of reasoning (argumentation) on which a subsequent decision is based, thereby increasing decision quality. When this decision is eventually implemented, it is more likely to improve system behavior (Hsiao & Richardson, 1999; Rouwette, Größler & Vennix, 2004; Sterman, 1994).

In order to build a simulation model, information about the causal relations within a system is required. Usually information on relevant causal relations is distributed among decision makers with different disciplinary and/or functional backgrounds. Each decision maker will bring specialized expertise and information to the group discussion (Mintzberg, 2004; Vennix, 1996). The exchange of viewpoints between decision makers will in general result in broader discussion on the causal relations within a system (Mintzberg, 2004).

This paper will address group model building; a facilitated modeling approach to system dynamics. Group model building involves decision makers in the model building process (McCardle-Keurentjes, Rouwette & Vennix, 2008; Andersen & Richardson, 1997; Andersen, Vennix, Richardson & Rouwette, 2007; Vennix, 1996). The researcher and the decision makers jointly structure, define, and evaluate the situation of interest and develop plans for action (Franco & Montibeller, 2009; Franco & Rouwette, 2011; Rouwette, Vennix & van Mullekom, 2002). An outcome of group model building is increased information exchange between decision makers by fostering group discussion, which in turn improves the insights of the decision makers into the causal structure and its relationship to system behavior (Vennix 1996).

Power-leveling

Communication theory offers a possible approach to investigate the issues of increased information exchange between decision makers. According to Rouwette (2010) group model building has a positive effect on the communication process in comparison to regular meetings without decision-making support. (In this paper decision-making meetings without group model building are referred to as regular meetings.) This improvement may be the result of more comprehensible, legitimate, and accurate communicative exchanges during group model building meetings (Franco, 2006), which allows the participants to focus more on the exchange of arguments in the discussion (Rouwette, 2010; Rouwette, Vennix & Felling, 2009). This focus on the exchange of arguments will improve the quality of the argumentation process and thereby the quality of the subsequent decision.

In group model building meetings, a facilitator guides the process and elicits the viewpoints of the decision makers on the problem in order to construct a simulation model. The facilitator promotes a more equal contribution to the discussion by the decision makers compared to regular meetings. The facilitator accomplishes this by valuing the knowledge of each decision maker equally and treating all contributions to the discussion seriously. Moreover this helps to avoid getting involved in politicking (Vennix, 1996). Vennix (1996, 144) states: "*The central question is: how best to facilitate a group in such a way that an optimal solution to a problem is developed?… Power games are generally not very helpful to design this type of optimal solutions.… The best thing to do is to concentrate more on the group task or problem. By doing this the facilitator helps the group to surpass politicking behavior in the group*". Therefore group model building guidelines suggest that due to the guidance of a facilitator a so called power-even playing field is generated during a meeting. Yet the influence of power is a relatively unexplored area within group model building assessment studies (Bleijenbergh, Benschop & Vennix, 2008).

Each decision maker has a certain level of power within his/her organization (Borgatti, 2005; Fineman, Gabriel, & Sims, 2005; Emerson, 1979). The decision maker has the potential to exert this power during a meeting. Therefore this power attribute of the decision maker is referred to as the potential power (structural power) of a decision maker. The decision maker may choose to enforce his or her potential power during a meeting. The actual enforced power becomes evident from the behavior of the decision maker, and is referred to as behavior power (Brass, Burkhardt, 1993). When participants do not use their potential power a so-called power-even playing field appears. When a more power-even playing field is created during a meeting, it will potentially only exist during that meeting. However, in the long run a change in behavioral power may change the potential power of the participant (Lawler, Thye,

& Yoon, 2006; Brass, Burkhardt, 1993). This effect is beyond the scope of this paper. As mentioned before group model building guidelines suggest that through the guidance of a facilitator a more power-even playing field is created. If a facilitator succeeds in creating a more power-even playing field during a meeting, we refer to this as power-leveling.

This research will explore this potential effect of power-leveling using social exchange theory and in particular the contribution of Lawler and Yoon (1998) to this theory. Social exchange theory is founded by Homans in the late 1950s. Homans (1958) was one of the first social scientists to view social behavior as exchange. This approach has resulted in the theory currently known as the social exchange theory. Emerson (1976) introduced the concept of a social exchange network. Two actors in a social exchange relationship are called a dyad. Multiple social exchange dyads together form a network of social exchange relationships. Lawler and Yoon (1998) further extended the theory by analyzing the effects of power differences on the exchange relationship. Their theory focuses on the effect of power differences on the development of an exchange relationship. According to Lawler and Yoon, the difference in potential power (structural power) between two actors shapes their exchange relation (Lawler & Yoon, 1998; Lawler, Thyre & Yoon, 2008). Social exchange theory maintains that, during a regular meeting the larger the power difference between two actors, the less likely they are to interact. The reverse also holds: the smaller the power difference the more likely the actors are to interact, as shown in Figure 1. These predictions of social exchange theory can be rephrased as follows:

In regular meetings the power difference between decision makers influences the number of exchanges.

Application of this theory to group model building meetings implies that, due to power-leveling, group model building should lead to an increased number of exchanges between high-power difference dyads compared to a regular meeting. Since the maximum number of exchanges is limited by the duration of the meeting, a proportional increase in exchanges between high-power difference dyads in a group model building meeting will inevitably decrease the number of exchanges between low-power difference dyads. Figure 1 shows the effect of complete power-leveling on the number of exchanges as a result of group model building. This results in a second and third hypotheses:

In group model building meetings the power difference between decision makers has no significant influence on the number of exchanges.

The power difference between decision makers in group model building meetings has a weaker influence on the number of exchanges than in regular meetings.

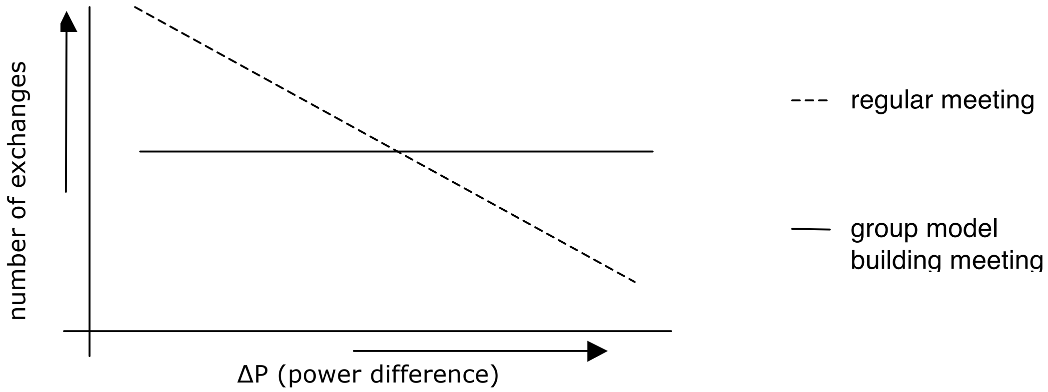

Figure 1. Number of exchanges versus power differences

Positioning of this research

This study continues a line of research at (or in collaboration with) Radboud University Nijmegen on effectiveness of group decision support (Akkermans, 1995; Kenis, 1995; Pala, 2008; Rouwette, 2003; Scheper, 1991; Vennix, 1990; Verburgh, 1994; Vriens, 1998; Franco & Rouwette, 2011). It also builds on research conducted at SUNY Albany (Richardson & Anderson, 2006; Anderson & Richardson 1997) and work done in the UK at Warwick and Hull University (Franco & Montibeller, 2010; Franco, 2009). This study is unique in using a controlled field setting to study the contribution of group model building to the communication process. The focus on the communication process links the sender and receiver in a knowledge sharing relationship (Hislop, 2002). Previous research focused on either the receiver or the sender perspective. This research contributes to the group decision support studies by linking the sender and receiver perspective by examining their interaction.

Learning, and changes in commitment and consensus have a relation to knowledge sharing about a problem. For example, knowledge sharing in the form of exchange of viewpoints about a problem is a necessary condition for consensus to emerge (Scheper, 1991 In: Rouwette, Vennix, van Mullekom, 2002). Rouwette's research focuses on the changes in attitudes and behavior as a result of participating in system dynamics group modeling approaches (Rouwette, 2003; Rouwette, Korzilius, Vennix, & Jacobs, 2011). In short, this line of studies looks at changes in attitudes and behavior towards a decision, resulting from receiving knowledge about the problem. This places his research at the receiving end of the knowledge sharing relationship.

A subject that recently has received attention in group model building assessment studies is knowledge sharing. A so-called hidden profile is present when knowledge is distributed across decision makers and they need to share their knowledge to select a superior decision (Stasser, 1992). The group model building process conforms to the properties of a hidden profile, since each decision maker brings his or her own expertise and information that is required to build the model. Research into the phenomenon of hidden profiles can be viewed as focusing on the sender in a knowledge sharing relationship. Research by McCardle-Keurentjes examines the effect of group model building on a hidden profile (McCardle-Keurentjes, Rouwette, Vennix, 2008; McCardle-Keurentjes, Rouwette, Vennix, Jacobs, 2009).

Research Method

This research will study the decision-making process. According to Eden (1995), decision-making in complex problem situations has the following properties: the subject matter is complex, the decision makers have extensive but specific knowledge on the problem at hand, the facilitators have to negotiate expectations with the decision makers, the decision makers have to work together after the decision making process, and the decision making process should create commitment for proposed actions. These properties make decision-making hard to capture in an experimental setting (Eden, 1995; Andersen & Richardson, 1997). Furthermore, decision-making has been shown to differ between artificial (experimental) and real world (field) domains (Ebbesen & Konečni, 1980; Lipshitz, Klein, Orasanu, & Salas, 2001). To capture the essence of real world decision making, this research will study the decision-making process in a field setting.

To analyze power-leveling in group model building sessions, we studied actual problems in a field setting at the Dutch Health Care Insurance Board (CVZ). CVZ integrates research, empirical data and practitioner's insights into healthcare policy recommendations for the Dutch government. Because system dynamics is well suited to address the dynamic complexity that characterizes many public health issues (Homer & Hirsch, 2006), CVZ is developing its competence to support research by constructing computer models of the problem of interest in interaction with content experts. We were able to evaluate both group model building meetings and regular meetings at CVZ.

In observing meetings we used the following procedure. All project meetings were videotaped for further analysis. Using videos as a data source provides us with the opportunity to study the process in more detail (Franco & Rouwette, 2011). This kind of observations provides an alternative to self-assessment and are less subjective compared to other data sources such as interviews (Rouwette, Vennix, van Mullekom, 2002). In all project meetings permission to videotape was acquired. Meetings proceeded as usual except for the presence of the camera. During the GMB meetings the procedure was as follows. The recorder (seated at the right hand of the facilitator) recorded the input using a computer aid that projects on a screen. The participants were positioned in a way that they all had a clear view on the projection screen. The facilitator guided the process; he elicited the input from the group and constructed the model (see Vennix (1996) for a full description of the GMB procedure).

Meetings and participants

In this paper one normal meeting (a) and one group model building meeting (b) were investigated. We will describe the subjects discussed during these two meetings to gain a better understanding of their complexity.

(a) The subject of the regular meeting was a structural change in the Dutch healthcare system. To regulate exceptional medical care the Dutch healthcare system has specific public policies. In the last years the expenses related to exceptional medical care are growing rapidly. The government wants to get a grip on these growing expenses by making a structural change in the policies. The CVZ set out to create an analysis of this problem and its implications for the Dutch healthcare system. A project team of five CVZ employees was established to discuss the content of the problem in several meetings. The project team consisted of two female and three male analysts, all experts on the national health system. The goal of the meetings was to formulate recommendations to the ministry of Health on the subject.

(b) The subject of the group model building meeting was a problem concerning the number of cataract treatments. Previous research has shown regional differences in the number of treatments, which may be an indication for the under- or over-treatment of this eye disease. The aim of the research project was to get more insight into the underlying structures that cause the differences in treatment. These insights can be used to adjust reimbursement policies of the Dutch government. CVZ has decided to start a system dynamics project to generate this insight. The project started with group model building sessions to create a causal model of the problem. The project team consisted of six CVZ analysts, three males and three females, and was facilitated by two male facilitators of Radboud University Nijmegen. Of the participants three had a medical background, one was a methodologist, and two were experts on the national health system. One of the latter experts also participated in the regular meeting. The meeting under investigation is the second group model building meeting, aimed at extending and elaborating a causal loop diagram of the issue at hand.

Procedure

This research is intended to be the first in a series of studies. Its success depends to a large extent on the feasibility of measurement of the two main concepts of power differences and the number of exchanges. As a first approach we will apply a simple operational definition.

<u>Power differences</u>

The definition of power applied in this research is the authority of an employee as perceived by his/her colleagues within an organization. As a consequence, the power difference in a dyad is the difference in perceived authority between two employees making up a dyad. This type of power measurement is based on the reputation method (Runhaar, Tigchelaar, & Vermeulen, 2006; Felling, 1974; Wolfinger, 1960).

To measure power, a matrix as shown in Table 1 was filled out by employees of CVZ who are in a position to observe relations between subjects in our study (the participants of the meetings). We refer to employees filling out this table as 'judges'. Some of the judges were participants of the projects under study. The matrix that was presented listed 16 CVZ employees, and one of the facilitators with whom the judges were acquainted. To reduce sequence effects the order in which the employees were listed in the table was randomized for each judge. Among the employees listed were the secretary, two department managers and the participants of the two projects. The judges were not aware of the 'special status' of the participants, nor were they informed about the research purpose of the questionnaire. In the matrix each dyad was represented by a cell. The task of a judge was to select which of the two employees in a dyad is the employee with the highest level of authority, according to his/her personal opinion. If employee A in Table 1 was perceived to have authority over B, then the judge was asked to write A in the corresponding cell. When the judge perceives the authority of employees to be equal, he/she was asked to write a question mark in the cell. Judges were asked to keep the number of question marks to a minimum. One should notice that the matrix in Table 1 is symmetric over its diagonal. Every dyad is described by two cells, for example [BC] and [CB]. By copying [BC] to [CB] the matrix is completely filled as shown in Table 1.

Employee	A	B	C	…	N
A					
B	A		B [CB]		
C	?	B [BC]			
…					
n					

Table 1. Score matrix, cells represent a dyad.

To calculate a power score the questionnaire the first step is to convert it into an adjacency matrix. In an adjacency matrix the cells represent the links between the employees in the dyad (Borgatti, 2005). The conversion consists of replacing the names in cell of Table 1 by a 1 or 0. When the name in the cell matches the name in the row it is replaces with a 1, because the employee in the row has perceived authority over the employee in the column. And the name is replaces with a 0 when it matches the name in the column, because the employee in the row has no perceived authority over the employee in the column. The questions marks are replaced with a score of 0.5.

The second step is calculating a power score for each employee. This is calculated by using Freeman's degree of centrality measure[1]. This degree of centrality refer to the number of other employees an employee is connected to (Freeman 1977, Bonacich, 1987). It is calculated by taking the sum of the rows in the adjacency matrix (Borgatti, 2005). The higher the score the greater the power of that employee. By ordering the power scores from high to low a ranking appears. Table 2 shows the adjacency matrix and power score.

Employee	A	B	C	…	N	Power
A		1	0,5			1,5
B	0		1			1
C	0,5	0				0,5
…						
N						

Table 2. Adjacency matrix and power score.

Before calculating an aggregate power score, it is required to check the reliability of the measure (IRR) and the level of agreement between the judges (IRA). "*These concepts simply differ in how they go about defining inter rater similarity. Agreement emphasizes the interchangeability or the absolute consensus between judges and is typically indexed via some estimate of within-group rating dispersion. Reliability emphasizes the relative consistency or the rank order similarity between judges and is typically indexed via some form of a correlation coefficient*" (LeBreton, & Senter, 2008, 816). Both measures are used to justify the aggregation the individual judges scores to a mean power rating for the employees.

The final step is to calculate the power difference matrix, based on the power scores. The cells in the power difference matrix represent the power difference in a dyad. For each dyad the difference is calculated by taking the absolute difference between the two power scores of the employees in the dyad. This results in a matrix as shown in Table 3.

[1] We have used Freeman's degree of centrality because due to the nature of communicative exchange Freeman's degree will give the same results as the more complex Bonacich measure for centrality (Bonacich, 1987).

Employee	A	B	C	…	N
A		0,5	1		
B	0,5		0,5		
C	1	0,5			
…					
N					

Table 3. Power difference matrix.

Five judges were consulted to measure the power differences between the employees. There is a strong agreement (IRA .819; $p < .01$) between the judges, because the IRA is above .80 (LeBreton, & Senter, 2008). Reliability (IRR .958; $p < .01$) is well above the acceptable minimum of .80 (Shrout, & Fleiss, 1979). This justifies the aggregation of individual judge scores to a mean power score for the employees. Table 4 and Table 5 shows the power difference matrix based on the mean power score as given by the judges for respectively the regular meeting and group model building meeting. Figure 1 shows the power differences for the regular meeting in a social network representation and Figure 2 for the group model building meeting. The width of the lines in these figures represents the power difference, the thicker the line the greater the power difference.

	M03	M04	M05	M06	M14	M17
M03		6,6	1,4	7,1	7,6	0,4
M04	6,6		8	0,5	1	6,2
M05	1,4	8		8,5	9	1,8
M06	7,1	0,5	8,5		0,5	6,7
M14	7,6	1	9	0,5		7,2
M17	0,4	6,2	1,8	6,7	7,2	

Table 4. Regular meeting power difference matrix; M03-M017 refer to participants

	M01	M03	M07	M08	M09	M10	M12	M14
M01		7,6	2,3	1	1	1,5	5,8	0
M03	7,6		9,9	8,6	6,6	6,1	1,8	7,6
M07	2,3	9,9		1,3	3,3	3,8	8,1	2,3
M08	1	8,6	1,3		2	2,5	6,8	1
M09	1	6,6	3,3	2		0,5	4,8	1
M10	1,5	6,1	3,8	2,5	0,5		4,3	1,5
M12	5,8	1,8	8,1	6,8	4,8	4,3		5,8
M14	0	7,6	2,3	1	1	1,5	5,8	

Table 5. Group model building meeting power difference matrix; M03-M017 refer to participants

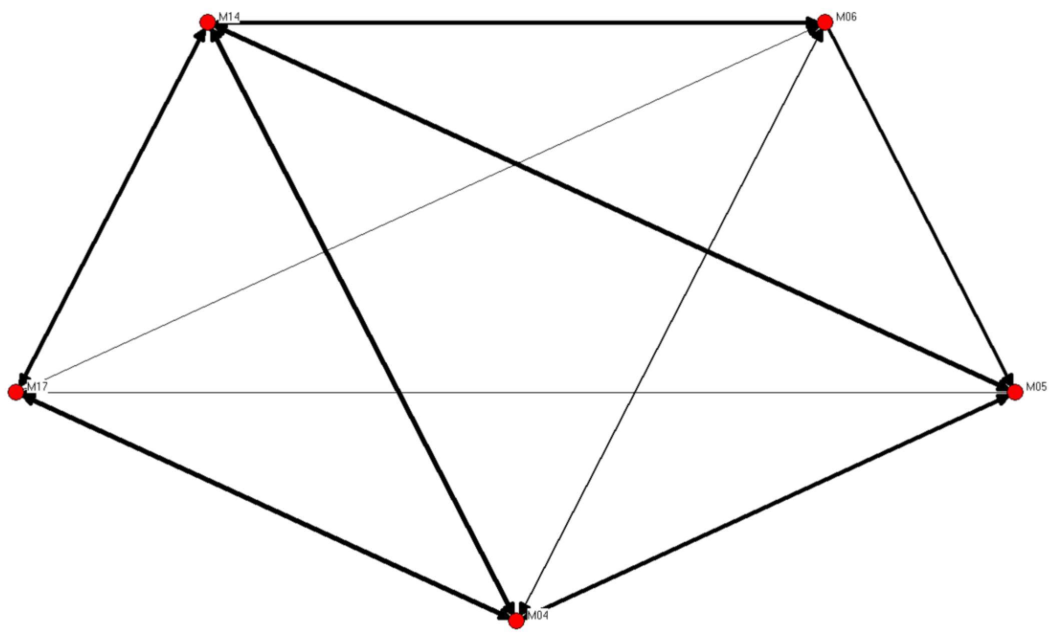

Figure 1. The regular meeting power difference network

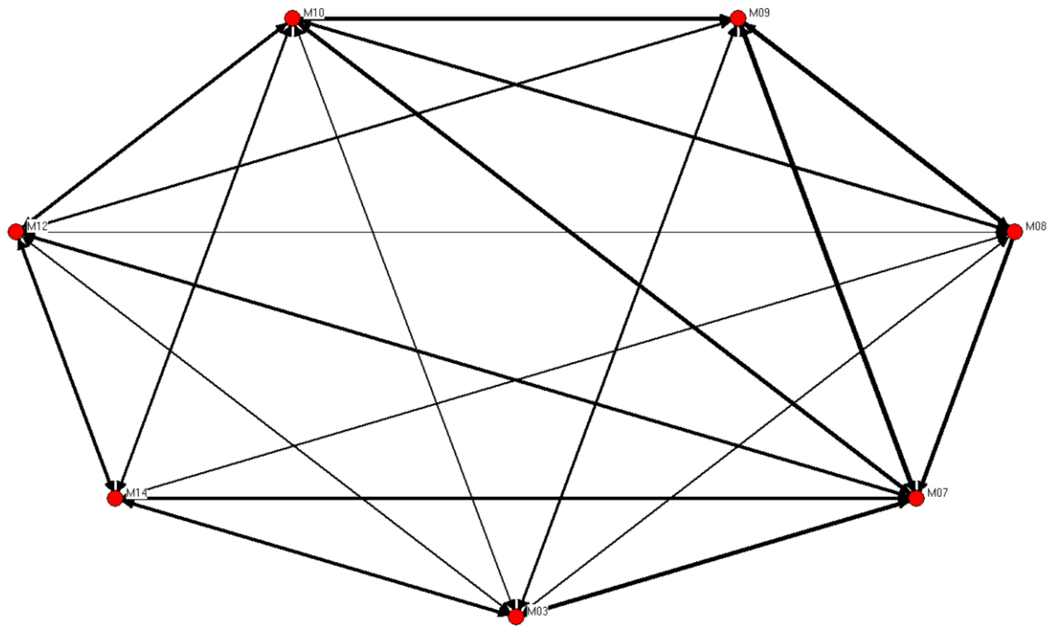

Figure 2. The group model meeting power difference network

Number of exchanges

The number of exchanges is defined in this paper as the number of verbal expressions directed to and meant for the other employee in the dyad. As mentioned before videotapes of the regular and group model building meeting were made. Three steps are required to quantify the number of exchanges. The first step is to make transcripts of the videotapes, the second step is to code the transcripts and the third step is to create an exchange matrix based on the coding.

The first step of creating the transcripts of the videotapes consisted of writing down all verbal expressions. The group model building meeting lasted for 114 minutes and the regular meeting lasted for 235 minutes. A transcription of the complete group model building meeting was produced. For the ease of comparison only the first 114 minutes of the regular meeting was transcribed.

Coding the transcripts was the next step. During the coding a coder not only read transcripts as presented in Table 6 but also watched the video footage. The coder did not participate in the meetings. The coder was asked to mark the participant that was addressed with each expression with x. For example in Table 6 expression 1243 is addressed to participant B. If two or more participants are addressed with a single expression, the coder is asked to mark ALL. A question mark was marked if the coder was unable to determine which participant was addressed.

The third and final step is to create an exchange matrix. The number of expressions per dyad is represented by two numbers, the sum of expressions (marked with a x) from participant A addressed to B, and the sum of expressions from participant B addressed to A.

Expression number	Participant	Expression	Directed to and meant for subject:				
			all	?	A	B	C
1243	A	They stated in that report, yes we do not trust the local governments				X	
1244	B	Yes			X		
1245	C	Really, did they state that?			X		
1246	A	Yes they did					X
1247	B	Mmm			X		
1248	A	Yes nice statement, sound really nice, but we are not convinced that the local governments will do it right				X	
1249	C	Article			X		
1250	A	And the argument was yes the ACP is not here to state that one local government act ok and the other does not				X	

Table 6. Coding schema

The transcribing resulted in 2776 expressions for the regular meeting and 2714 for the group model building meeting. This is more or less the same, as was expected because a similar time frame of both meetings was transcribed. Only expressions marked at the participant level are used during analyzes, i.e. expressions to ALL or ? are excluded from analyzes. During the group model meeting one of the participants arrived 30 minutes late and left 20 minutes early. This shorter presence will reduce the number of expressions from and addressed to this participant. Therefore this participant is excluded from further analyses. This leaves 2143 expressions for the group model building meeting and 2677 expressions for the regular meeting were used to construct the exchange matrices. The exchange matrices of the regular meeting is shown in Table 6 and group model building meeting in Table 7. The network representation of the exchange matrices is presented in Figure 3 for the regular meeting and Figure 4 for the group model building meeting. The width of lines in these figure represent the number of exchanges, the wider line the higher the number of exchanges.

	M03	M04	M05	M06	M14	M17
M03		60	279	281	76	0
M04	66		78	74	26	66
M05	291	84		290	76	291
M06	268	67	300		95	268
M14	73	27	71	95		73
M17	0	60	279	281	76	

Table 7. The regular meeting exchange matrix

	M01	M03	M07	M08	M09	M10	M12	M14
M01		38	33	27	3	27	6	24
M03	31		102	104	27	89	27	120
M07	46	119		61	12	53	31	92
M08	23	123	67		11	40	32	68
M09	4	28	13	13		17	10	9
M10	35	96	71	43	17		31	51
M12	8	37	38	28	11	29		36
M14	23	134	87	68	7	53	38	

Table 8. The group model meeting exchange matrix

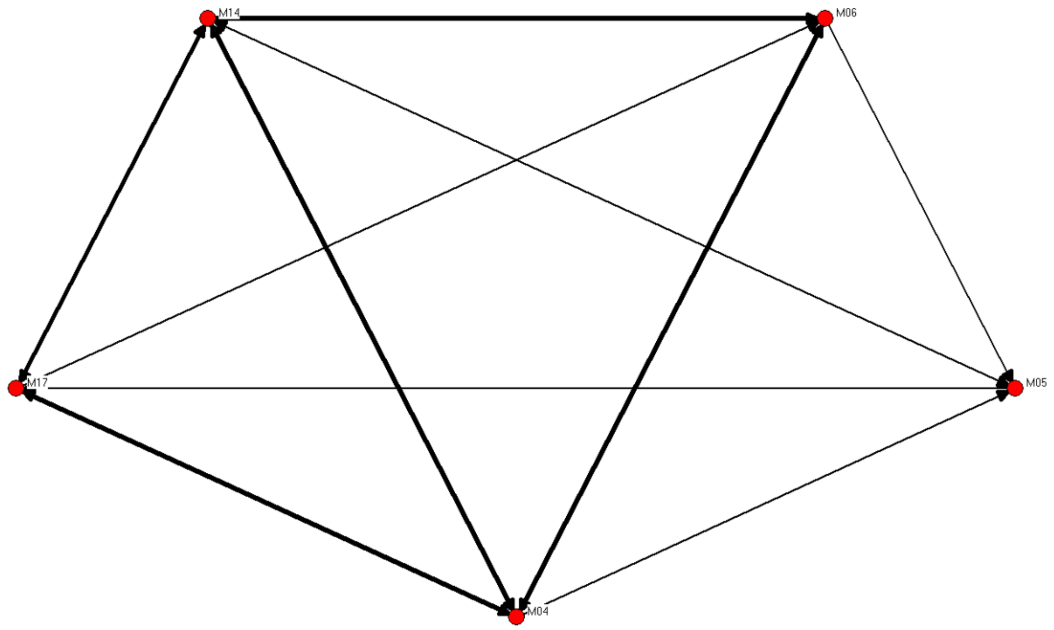

Figure 3. The regular meeting exchange network

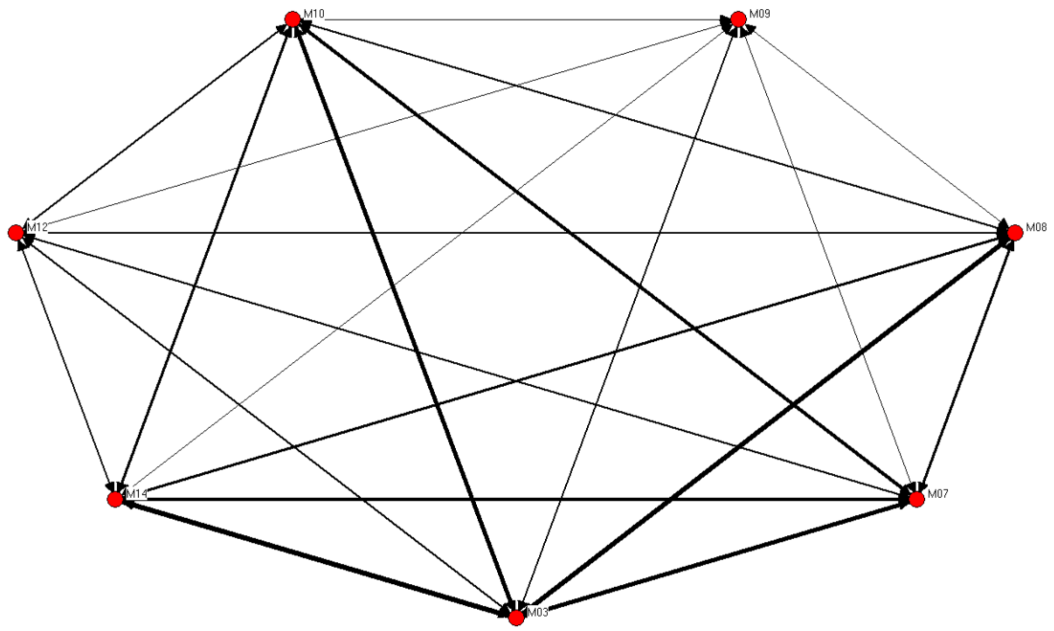

Figure 4. The group model meeting exchange network

Analyses

The unit of analysis in this research are the dyads within a meeting. The attributes of the dyads are represented by matrices, as shown above. The software UCINET is used to test the hypotheses by comparing the matrices (Borgatti, Everett, & Freeman, 2002). This software uses the Quadratic Assignment Procedure (QAP). QAP permutes the matrices to enlarge the population, which results is a hyper-geometric distribution. The hyper-geometric distribution is considered to be the equivalent of a normal distribution which justifies the use of parametric tests. Such as the Pearson's Correlation test that was used to test the hypotheses (Hubert, & Schultz, 1976). The testing of the three hypotheses is discussed below.

In regular meetings the power difference between decision makers influences the number of exchanges.

The first hypothesis is tested by calculating the correlation between the power difference and the number of exchanges of the normal meeting. A significant match between the power difference and exchange matrices is found (-.751; $p < .05$). A negative correlation was to be expected, because the social exchange theory states that a higher power difference results in less exchange. In Figure 5 the relationship between the power difference and the number of exchanges is plotted. The diamonds represent the 30 cells of the matrix, that were measured for 15 dyads in the regular meeting. The dashed line in Figure 5 shows that during a regular meeting an increase in power difference will decrease the number of exchanges in a dyad. This finding supports the prediction of the social exchange theory that the number of exchanges between two actors is dependent on their power difference.

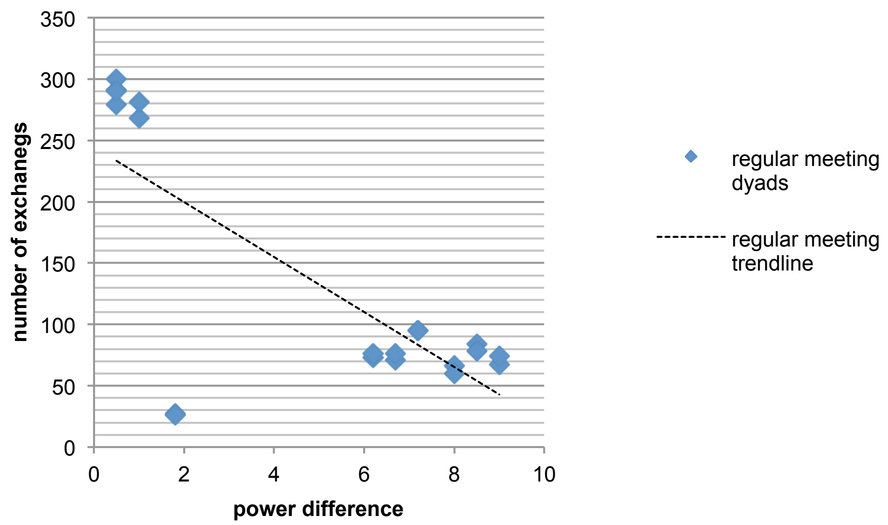

Figure 5. Regular meeting: number of exchanges versus power difference

In group model building meetings the power difference between decision makers has little influence on the number of exchanges.

The second hypothesis is tested by calculating the correlation between the power difference and the number of exchanges for the group model building meeting. A significant match between the power difference matrix and exchange matrix is found (.470; p< .05). Figure 6 shows the relationship between the power difference and the number of exchanges. The diamonds represent the 56 cells of the matrix, that were measured for 28 dyads within the group model building meeting. Contrary to expectations, the continuous line in Figure 6 indicates that a higher power difference results in a higher number of exchanges.

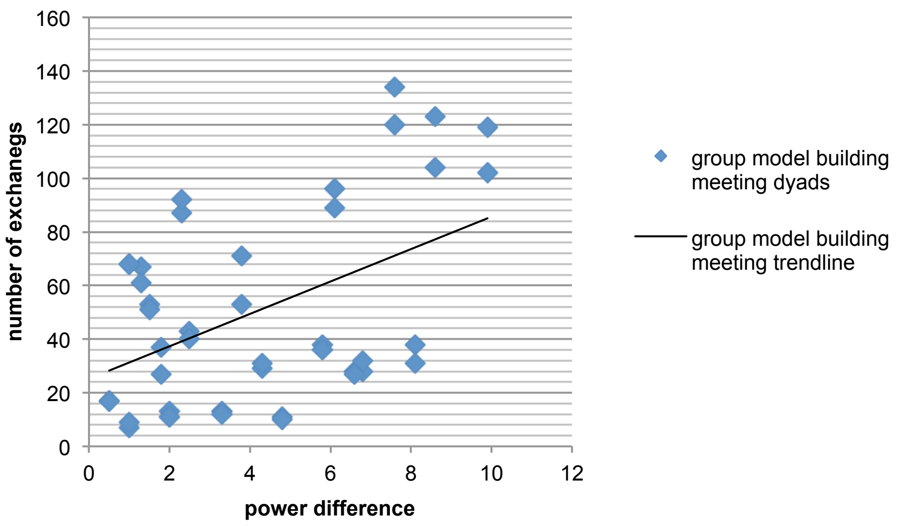

Figure 6. Group model building meeting: number of exchanges versus power difference

A possible explanation is the effect of including the facilitator among participant dyads in the analyses. The power score (as perceived by the judges) of the facilitator is low and therefore the power difference between the participants and the facilitator are high. Due to the nature of process facilitation the number of exchanges between the facilitator and participants is high. The combination of the high power difference and the high number of exchanges between the facilitator and participants may have biased the result. This gives rise to the question if incorporating the dyads between the facilitator and participants is suitable for the analysis.

When the facilitator to participant dyads are excluded, the correlation between the power difference and number of exchanges clearly drops. This correlation becomes insignificant (-.154; p= .306). The drop in correlation in itself is significant (from .470 to -.154; p<.05 tested 1-sided) and illustrates the important role for the facilitator. The continuous line in Figure 7 shows the power difference to the number of exchanges relative without the facilitator to participants dyads. These findings suggest that there is a none or low correlation between the power difference and the number of exchanges during the group model building meeting when the facilitator is excluded.

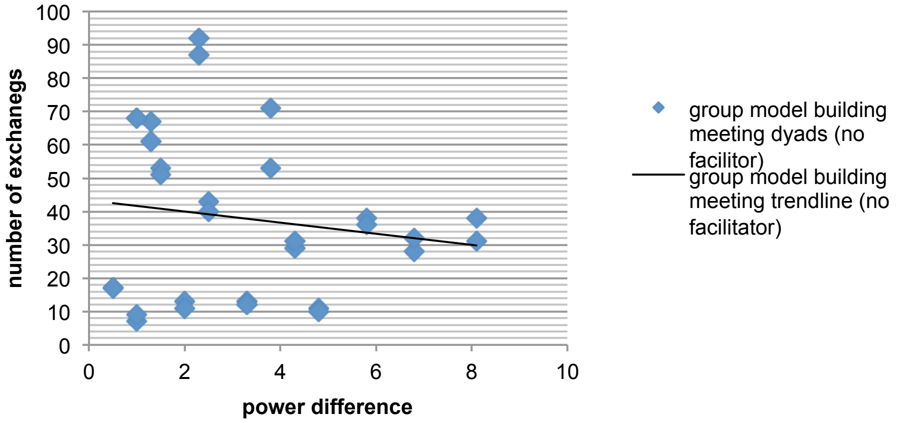

Figure 7. Group model building meeting, facilitator excluded: number of exchanges versus power difference

The power difference between decision makers in group model building meetings has less influence on the number of exchanges than in regular meetings.

For this analysis we compare the correlations found for the regular meeting and the group model building meeting with the facilitator excluded from the analyses. The two correlations are significantly
(-.751 -.154; p<.05 tested 1-sided) different from each other (p<< .05). The power difference in a group model building meeting has less impact on the number of exchanges compared to the regular meeting, this suggests power leveling as a result of group model building. The hypothesis is not rejected. However, because we only compare two meetings this analysis should be interpreted with care.

Discussion

On the basis of an analysis of the complete group model building meeting and the first 114 minutes of the regular meeting, the assumption of power-leveling as an effect of group model building seems to hold. As mentioned before each decision maker has his own specialized expertise and information on the subject discussed during a meeting. Sharing these viewpoints leads to a broader discussion and will increase decision quality. Due to power-leveling during the group model building meeting a low ranking participant was able to bring his own viewpoints to the discussion. This participant, for instance, responded to a high ranking participant by introducing the effect of reimbursement of cataract treatments on the reimbursement budget. This exchange changed the model structure concerning the rewards of physicians. In a regular meeting it would be less likely for this exchange to occur, and his helpful input would not have been used in the discussion. This illustrates why group model building may be helpful in designing better solutions.

These findings are promising but must be viewed as a first study into the prediction of power-leveling through group model building. Despite the possibility of a spurious finding, the results seem to be promising which encourages further research. The results of this study support the definitions used for power and the number of exchanges in a dyad. In order to solidify the findings the number of meetings analyzed needs to be increased to get a more representative measure of the number of exchanges for a regular and group model building meeting. Moreover the use of a single coder may also have influenced the results of this study, therefore multiple coders are required for a more reliable measurement of the number of exchanges.

Future research on this subject offers the possibility to explore the definition of exchanges in more detail. The definition can move from the level of exchanges to the level of arguments and viewpoints to eventually the level of knowledge-sharing. This would require a different coding scheme, based on communication theory and knowledge sharing theory. The link between the social exchange theory and group model building theory which we have only begun to unravel in this study, makes further research in this direction promising.

Another route for further research is found in the occurrence of the concept of commitment in both social exchange theory and group model building theory. The relationship between commitment and power differences makes it especially interesting to assess the effectiveness of group model building on these issues. There are many roads to explore from here. A necessary road to be taken is to strengthen and replicate the results as presented in this paper, to further support the hypothesis of power leveling by group model building.

Literature

Akkermans, H.A. (1995). *Modelling with managers: participative business modelling for effective strategic decision-making.* Doctoral thesis. Eindhoven University of Technology, Eindhoven The Netherlands.

Andersen, D. F. & Richardson, G. (1997). Scripts for group model building. *System Dynamics Review, 13,* 107-129.

Andersen, D. F. Vennix, J. A. M. Richardson, G. P. & Rouwette, E. A. J. A. (2007). Group model building: problem structuring, policy simulation and decision support. *Journal of the Operational Research Society, 58,* 5, 691-694.

Bleijenbergh, I.L., Benschop, Y.W.M. & Vennix, J.A.M. (2008). *Making Gender Equality a Shared Problem in Organizations: Group Model Building as a Gender Mainstreaming Method.* Critical management Studies Research Workshop, USC Los Angeles, 7-8

Bonacich, P. (1987). Power and Centrality: A Family of Measures. *American Journal of Sociology, 92,* 5, 1170-1182

Borgatti, S.P. Everett, M.G. & Freeman, L.C. (2002). Ucinet for Windows: Software for Social Network Analysis. Harvard, MA: Analytic Technologies.

Borgatti, S.P. (2005). Centrality and network flow. *Social Networks, 27,* 55-71

Brass, D.J. Burkhardt, M.E. (1993). Potential Power and Power Use: An Investigation of Structure and Behavior. *The academy of Management Journal, 36,* 441-470

Ebbesen, E. & Konečni, V. (1980). *On the External Validity of Decision –Making Research: What Do We Know About Decisions in the Real World?* In T. Wallsten (Ed.), Cognitive Processes in Choice and Decision Behavior (pp. 21-45). Hillsdale, NJ: Lawrence Erlbaum Associates.

Eden, C. (1995). On evaluating the performance of 'wide-band' GDSS's. *European Journal of Operational Research, 81,* 302-311

Emerson, R.M. (1976). Social Exchange Theory. Annual Review of Sociology, 2, 355-362.

Felling, A.J.A. (1974). Lokale macht en netwerken Een methodologische terreinverkenning. Alphen aan den Rijn / Brussel, Samson Uitgeverij

Fineman, S. Sims, D. & Gabriel, Y. (2005). *Organizing and Organizations. London, SAGE Publications Ltd*

Franco, L.A. (2006). Forms of conversation and problem structuring methods: a conceptual development. *Journal of the operational research society, 57,* 7, 813-821

Franco, L.A. & Montibeller, G. (2009). *Facilitated Modelling in Operational Research*. LSE OR Working Paper Series 09-109

Franco, LA (2009b). Problem Structuring Methods as Intervention Tools: reflections from their use with multi-organizational teams. OMEGA: The International Journal of Management Science, 37, 1, 193-203

Franco, L.A. & Rouwette, E.A.J.A. (2011). Decision Development in Facilitated Modelling Workshops. *European Journal of Operational Research,* 212, 164-178

Freeman, L.C. (1977). Centrality in social networks conceptual clarification. *Social Networks, 1,* 215-239

Homans, G.C. (1958). Social Behaviour as Exchange. *The American Journal of Sociology, 63,* 6, 1858-1958.

Homer, J.B. & Hirsch, G.B. (2006). System Dynamics Modeling for Public Health: Background and Oppertunities. *American Journal of Public Health, 96,* 3, 452-458

Hsiao, N. & Richardson, G. P. (1999). *In Search of Theories of Dynamic Decision Making: A Literature Review.* Paper presented at the 17th International Conference of the System Dynamics Society, New Zealand: Wellington

Hubert, L. J. & Schultz, J. (1976). Quadratic assignment as a general data analysis strategy. *British Journal of Mathematical and Statistical Psychology, 29*, 190-241.

Lawler, E.J. & Yoon, J. (1998). Network Structure and Emotions in Exchange Relations. American *Sociological Review, 63,* 6, 871-894

Lawler, E.J., Thye, S.R. & Yoon, J. (2006). Commitment in Structural Enabled and Induced Exchange Relations. *Social Psychology Quarterly, 69,* 2, 183-200

Lawler, E.J., Thye, S.R. & Yoon, J. (2008). Social Exchange and Micro Social Order. American *Sociological Review, 73,* 4, 519-542

LeBreton, J.M. & Senter, J.L. (2008). Answers to 20 Questions About Interrater Reliablility and Interrater Agreement. *Organizational Research Methods, 11,* 4, 815-852

Lipshitz, R., Klein, G. A., Orasanu, J. & Salas, E. (2001). Taking stock of naturalistic decision making. *Journal of Behavioral Decision Making, 14*, 331-352.

McCardle-Keurentjes, M.H.F., Rouwette, E.A.J.A & Vennix, J.A.M. (2008). *Effectiveness of group model building in discovering hidden profiles in strategic decision-making.* In B.C. Dangefield (Ed.), Proceedings system dynamics Conference Athens, 1-13. Athens: System Dynamics Conference.

Mintzberg, H. (2004). *Managers, not MBAs: A hard look at the soft practice of managing and management development.* San Francisco, Berrett-Hoehler Publishers, Inc.

Richardson, G.P. Anderson, D.F. (2006). *Teamwork in group model building. Systemdynamics review, 11,* 2, 113-137

Rouwette, E.A.J.A. (2003). *Group model building as mutual persuasion.* Nijmegen, Wolf legal Publishers

Rouwette, E.A.J.A. (2010). Facilitated modeling in strategy development: measuring the impact on communication consensus and commitment. *Journal of the Operational Research Society, 62,* 879-887

Rouwette, E.A.J.A., Vennix, J.A.M. & Felling, A.J.A. (2009). On Evaluating the Performance of Problem Structuring Methods: An Attempt at Formulating a Conceptual Model. *Group Decision and Negotiation,18,* 6, 567-587

Rouwette, E.A.J.A., Vennix, J.A.M. & van Mullekom T. (2002). Group model building effectiveness: A review of assessment studies. *System Dynamics Review, 18,* 1, 5-45.

Rouwette, E. A. J. A., Größler, A. & Vennix, J. A. M. (2004). Exploring influencing factors on rationality: A literature review of dynamic decision-making studies in system dynamics. *Systems Research and Behavioral Science, 21,* 4, 351-370

Runhaar, H. Tigchelaar, C. & Vermeulen, W.J.V. (2006). Environmental Leaders: Making a Difference. A Typology of Environmental Leaders and Recommendations for a Differentiated Policy Approach. *Business Strategy and the Environment, 17,* 160-178

Vennix, J. A. M. (1996). *Group model building. Facilitating team learning using system dynamics.* Chichester, Wiley

Wolfinger, R.E. (1960). Reputation and Reality in the Study of "Community Power". *American Sociological Review, 25,* 5, 636-644

Stasser, G. (1992). Information salience and the discovery of hidden profiles by decisionmaking groups: A "thought experiment". Group Decision Making, 52, 1, 156-181.

Shrout, P.E. & Fleiss, J.L. (1979). Interclass Correlations: Uses in Assessing Rater Reliability. *Psychological Bulletin, 86,* 2, 420-428

Simon, H.A. (1991). Bounded Rationality and Organizational Learning. *Organization Science, 2,* 1, 125-134

Sterman, J. (1994). Learning in and about complex systems. *System Dynamics Review, 10,* 2-3, 291-330