

Group model-building: what does the client think of it ?

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Abstract

In recent years many system dynamics modelers have pointed out that for effective implementation of model results it is essential that the client participates in the model-building process. This has led to various more or less successful approaches in group model-building. However, up to now little systematic research has been conducted in the area of effectiveness of group model-building. Systematic evaluation of group model-building is important in order to a) understand how clients and organizations are affected by group model-building; and b) improve the effectiveness of the group model-building process. In this paper evaluation results are presented of four model-building projects based on client's opinions of the successfulness of these projects.

The problem

System dynamicists have long recognized the importance of involving the client in the process of model-building (Forrester, 1961; Roberts, 1978; Weil, 1980; Meadows and Robinson, 1985). Various system dynamics modelbuilders have designed more or less effective procedures to involve a client group in the process of designing a model. In their paper on knowledge elicitation for model building Vennix et al. (1992) point out that there exists a variety of approaches to client involvement under such diverse names as group model-building, interactive model-building, computer-based learning environments, Strategic Forum etc. However, there does not seem to be a unified body of knowledge from which modelers can derive methodological guidelines to develop group model-building procedures.

At the same time there is also no systematic evaluation of group model-building projects. Although various modelers within the system dynamics community experiment with group model-building projects, almost nobody seems to pay systematic attention to the impact of these procedures on the client organization. This is in sharp contrast with habits within for instance the GDSS community where laboratory experiments on the effectiveness of these systems abound (see for instance McCart and Rohrbaugh, 1989; Nunamaker et al., 1991)

Systematic evaluation of group model-building procedures, however, is of the utmost importance for at least two reasons. The first is that through conducting evaluation research one is forced to think about the question what benefits might accrue from group model-building for the client organization. The second and more important is that through systematic research, system dynamicists will be in a position to systematically refine their methods and thus the effectiveness of group model-building.

In this paper we will present the results of an evaluation of four different group model-building projects. Model-building in all these cases was limited to the design of conceptual models and was carried out with real policy- and decision makers.

In the next section we will first describe the subject of the evaluations, which is closely related to the objectives of the model-building projects. Next we discuss the the method for data gathering. After this we will briefly describe the four projects,

and subsequently we will present the main results. The paper closes with some conclusions and a discussion of the results.

Objectives of the evaluation

The first question to be addressed is what will be evaluated. This depends on the goals of a group model-building project. Several authors have mentioned a number of useful functions of models. For instance, Quade (1982) and Meadows and Robinson (1985) emphasize the fact that models are useful for communication and integration of various ideas about a problem. Others have stressed the importance of models as individual and organizational learning devices (De Geus, 1988; Lane, 1992; Morecroft, 1988, 1992; Senge 1990). In particular De Geus (1988) and Senge (1990) point towards the importance of sharing mental models and the building of shared vision within a learning organization. Computer models are supposed to aid this organizational learning proces and to promote building shared vision. A function of group model-building which is less known but probably most important, is the creation of commitment with respect to the solutions to the strategic problem.

Method

Since little systematic empirical evaluation research has been conducted up to now (for exceptions see Vennix, 1990; Verburch, 1993), we decided to rely on the opinions of participants in these group model-building projects. Hence, we designed a questionnaire which was filled out by participants after the last session of the model-building proces. We have used the four aspects mentioned above to build our questionnaire. We framed questions aimed at evaluating to what extent the group model-building project had:

- created insight in the strategic problem (i.e. learning);
- facilitated sharing mental models and communication about the problem;
- created shared vision about the problem; and
- fostered commitment.

In order to prevent the framing of the questions to affect the type of responses elicited, we decided to formulate a set of questions (four to seven questions) covering each of the four dimensions. For example in the first category one of the questions is: "The proces of model-building has increased my insight into the problem". Another example is "The proces of model-building has increased my insight into the possible consequences of the problem for my organization". The questions are of the Likert type and can be answered on a scale ranging from 1 (totally disagree) to 5 (totally agree). In addition to questions on the potential effects of group model-building we also included a question in which the respondent was asked to rate the degree in which various elements had in his view contributed to the overall succes of the project. The elements we distinguished are (cf. McCart and Rohrbaugh, 1988):

- the fact that the sessions were held away from the office,
- the use of causal diagrams,
- the presence of an outside facilitator,
- the open character of the discussions,
- the visualization of the diagrams,
- the use of workbooks and
- the formal structuring of the meetings.

Finally, we included questions about the importance, usefulness, and efficiency of the model-building proces.

The questionnaire was not exactly the same in all four cases. After having tested the questionnaire in the first two cases (to be described below), we decided to adapt it slightly, because it became clear that a number of questions had to be stated more clearly. With regard to the above four dimensions this resulted in a set of 20 common questions which were the same for all four groups and which were distributed over the four dimensions mentioned earlier.

Before presenting the cases and the results, we would like to emphasize that the results have to be interpreted with some caution, because the sample exists of only 26 respondents. In this sense the current study clearly has an exploratory character. The results will have to be tested more rigourously in future projects.

The cases

Case 1: Department of Transport and Public Works

The first case was part of a larger research project. In this so called 'Nostradamus project', the Dutch Ministry of Transport and Public Works made a first attempt to change ordinary strategic decision making procedures by trying to involve more of their management teams in this proces. Their ultimate goal is to transform this department into a learning organization. In the first stage of this project their management teams (25 teams) were given a two day workshop which had two objectives:

- increase the awareness within the teams of relevant future developments in the environment of the department;
- increase each team's level of creativity in generating options in various future worlds.

An important methodological device used in this training session is the scenario planning technique. This technique was largely adopted from the Shell oil company (see de Geus, 1988). In addition, teams were also trained in the use of the so called Hexagon technique (Hodgson, 1992). The sessions, which took place in the second half of 1992, were guided by group facilitators.

One of the elements that could be selected by any team to analyse their strategic issues was conceptual system dynamics model-building. In order to evaluate the usefulness of system dynamics for the training sessions in the second half of 1992, a series of test sessions were conducted with an ad hoc team composed of eight persons from within the organization. In eight three hour session this group modeled two so called dilemmas, which had previously been formulated based on a number of interviews with persons within and outside the organization. After these sessions we asked the participants to fill out the questionnaire. (Note that this is the only ad hoc group as opposed to the others).

Case 2: Department of Shipping and Marine Affairs

In this case the department had serious trouble in deciding on their future strategy. This department is responsible for three different strategic areas: the Northsea, the Dutch harbours, and the Dutch commercial fleet. One major problem this department was faced with was the steadily decreasing number of ships sailing under the Dutch flag. More and more ships tend to sail under foreign flag because of tax reductions and less stringent regulations. Several people within the department felt that something needed to be done, while others held the opinion that this proces was difficult to stop and one could just as well stop the subsidies to the Dutch fleet,

because it was a waste of money anyway. It was decided to use conceptual system dynamics model-building to get more insight into the nature of this problem and to arrive at a strategic choice. In three sessions of three hours each with nine participants the problem was modeled leading to a quick consensus that all three strategic areas (Northsea, Dutch harbours and Dutch fleet) needed to be covered in the future, because the causal model revealed that the three were strongly interrelated. In other words, loosing the fleet sailing under Dutch flag would in the long run result in the loss of influence with regard to the other two strategic areas which, in turn would jeopardize the existence of the department as a whole.

Case 3: The department of Transport and Public Works: an integral policy approach to the Dutch river system.

In this case the problem was one of an integral policy approach to the Dutch river system. The rivers in the Netherlands serve a multitude of functions: shipping, recreation, winning of raw materials, sailing, etc. Optimizing one of the functions frequently leads to decreasing the value of one or more of the other functions. By applying conceptual model-building, it was hoped that more insight could be gained in the interrelationship between the rivers' functions. The ultimate goal was to create policies which were internally consistent and aiming at an integral policy with regard to the Dutch rivers. With this group of six persons three sessions were conducted.

Case 4: Cooperation between small divisions in a large service organization

In this case a large service organization entering the international market had problems of cooperation between their relatively small units. Model-building with a group of about six managers was used to analyse this problem in four sessions and to come to a number of options to solve this problem, which was impeding their penetration in the global marketplace (see also Akkermans et al. in this proceedings).

Results

In this section we will present the main overall results for the evaluation of the four cases discussed in the previous section (the total group consists of 26 persons). We will first start with the participants' opinions on the usefulness, the importance and the efficiency of the model-building sessions. Next, we will present the results with regard to the four dimensions: learning, communication, shared vision, and commitment. Finally the contribution of the various elements to the outcome of the model-building sessions will be described.

Participants' opinion on the importance and usefulness of the sessions

The first three groups were asked whether they thought that having participated in the sessions was important. The scores range from 1 (very unimportant) to 5 (very important). They were also asked whether the sessions were useful for strategic decision making within their organisation. These scores range from 1 (very unuseful) to 5 (very useful).

Table 1: Participants' opinion on importance and usefulness of the sessions (N=21)

	mean	minimum	maximum
importance sessions	4.33	4.00	5.00
usefulness sessions	4.23	3.00	5.00

As the table shows both the importance of the sessions and the usefulness of the sessions were rated very high (mean 4.33 and 4.23 respectively). Furthermore, participants' opinions between the four groups didn't differ very much, as can be seen from the small range of the scores. Overall the participants seemed to find the sessions very important and also very useful for strategic decision making within their organisation.

Participants' opinion on the efficiency of model-building

All participants were asked whether model-building is an efficient approach to study their strategic problem. The next table contains the results of the answers to this question. The scores ranged from 1 (disagree very strongly) to 5 (agree very strongly)

Table 2: Participants' opinion on the efficiency of modelling (N=26)

	mean	minimum	maximum
modelling is efficient	3.44	2.00	5.00

As can be seen from the table, the participants rated the efficiency of modelling less high than the importance and usefulness of the sessions (mean 3.44). This somewhat lower score is partly caused by the fact that the first group needed about eight sessions to model two different problems, while these sessions were spread over a period of about five months, which might have made model-building less efficient in their view. The average score for this first group is clearly lower than of the other groups (i.e. 2.85).

Participants' opinion on the four dimensions: learning, communication, shared vision and commitment

As stated, we defined a number of questions for each of the four dimensions: learning, communication, shared vision, and commitment. The first thing we did was to examine whether the four dimensions that were discerned in advance theoretically could be confirmed by the data. Therefore item rest correlations were calculated for each of the four dimensions. Variables that correlated negatively or below .10 with the sum of the rest of the scale were eliminated from the analysis. Eventually, it turned out that the four dimensions needed slight changes. The 'learning' dimension (seven indicators) and the 'commitment' dimension (two indicators) remained unchanged, but three questions of the original seven questions that formed the 'communication' dimension, and one question of the original three questions that formed the 'shared vision' dimension, had to be eliminated.

Next, the scores on the questions were summed over each dimension to provide a score for each respondent on the four dimensions. Scales for these dimensions run from 1 (disagree very strongly) to 5 (agree very strongly).

Table 3: Participants' opinion on the contribution of the model-building proces on four dimensions (N=26)

	mean	minimum	maximum
insight into the problem	3.78	2.71	4.57
quality of communication about the problem	3.85	2.75	4.75
degree of shared vision	3.92	3.00	4.50
level of commitment	3.58	2.50	5.00

The questions were framed in such a way that the scores in this table have to be interpreted as follows: as a consequence of applying model-building the insight into the problem has increased. Furthermore, model-building has improved the communication about the problem, and created a shared vision on the problem. Finally commitment has been created for the conclusions that followed from the model-building proces.

The first thing to be noted is that the scores on all four dimensions are well above 3.0, which is rather high. In addition, the difference between the four average scores seems negligible. The highest score is obtained for fostering shared vision through model-building. This is followed by the quality of the communication during the proces and insight in the problem obtained as a consequence of model-building. The lowest score is obtained for the level of commitment.

Participants' opinion on the quality of the sessions as compared to regular meetings

Actually the above scores do not tell us very much, since it might well be possible that in regular meetings on strategic issues (without applying model-building) one might obtain even higher scores. In order to be able to draw conclusions with regard to this issue, one would have to design an experiment to control for these two conditions. In our case this could not be accomplished. Hence, we decided to ask participants their opinion about a comparison of these sessions with their regular meetings on similar strategic issues. This question was, however, only added to the questionnaire for the third and fourth group. We do not have data on this question for the first two groups. Respondents of the last two groups (N=10) were thus asked whether, if compared to regular strategic meetings of their team, they thought that through these model-building sessions they had:

- got more insight ,
- got insight more quickly,
- communicated better,
- built a shared vision more quickly,
- built a more clear shared vision,
- created commitment more quickly and
- created more commitment.

Table 4: Participants' opinion about the quality of the sessions compared to regular meetings (N=10)

	yes	no	missing
more insight	5	4	1
more quickly insight	7	1	2
better communication	6	3	1
more quickly shared vision	6	2	2
more clear shared vision	5	4	1
more quickly commitment	4	4	2
more commitment	6	4	0

Answers on the above questions reveal that the best score is obtained for more quickly acquired insight (7 x yes, 1 x no and 2 missing), for more quickly acquired shared vision (6 x yes, 2 x no and 2 missing), and better communication (6 x yes, 3 x no and 1 missing).

Contribution of various elements

We also asked participants in the various groups what elements contributed most to the succes of the group model-building exercise. We distinguished seven different elements (see also McCart and Rohrbaugh, 1989):

- the fact that the sessions were held away from the office,
- the use of causal diagrams,
- the presence of an outside facilitator,
- the open character of the discussions,
- the visualization of the diagrams,
- the use of workbooks and
- the formal structuring of the meetings.

Note: items 1 and 7 have been left out of the analyses. The fact that the sessions were held away from the office has been left out, because this only applied to the first group. The formal structuring of the meetings has been left out, because only a small number of participants felt that the meetings were formally structured.

The scores on the scale ranged from 5 (contributed very much) to -5 (obstructed the sessions).

Table 5: Contribution of various elements to succes of model-building sessions (N=26)

	mean	minimum	maximum
the use of causal diagrams	3.46	-3.00	5.00
the presence of an outside facilitator	3.80	1.00	5.00
the open character of the discussions	3.42	1.00	5.00
the visualization of the diagrams	3.28	1.00	5.00
the use of workbooks ¹	2.65	0.00	5.00

The figures in the table indicate that, according to the respondents' opinions, all of the elements mentioned did contribute to the succes of the sessions. In addition, the presence of an outside facilitator contributed most to the overall success of the model-building sessions (average score = 3.8). This is followed by the use of causal

¹ The average scores for the contribution of the workbooks is based on the scores of the first, third and fourth group, because the second group made no use of workbooks.

diagrams and the open character of the discussion. The lowest score is obtained for the use of the workbooks, but a clear difference between the four groups exists. It is interesting to see whether the above results are corroborated by a regression analysis. Regression analysis also permits us to make a breakdown of the contribution of the various elements to the four dimensions distinguished previously (insight, communication etc.). Since we did not have theoretical predictions of which effect might contribute to which dimension we performed exploratory (stepwise) regression analyses for each of the four dimensions where the elements served as the independents. The results are shown in the table below.

Table 6: Regression analysis for four dimensions (dependents) and various contributions (independents) N=26

	use of causal diagrams	presence of outside facilitator	open character of discussion	visible projection of diagrams	use of workbooks
insight into the problem			.21 (R ² =.35)		
quality of the communication about the problem					
degree of shared vision				.15 (R ² =.18)	
level of commitment		.25 (R ² =.18)			

Note: the cells contain those b's which are significant at the .05 level. The figures between brackets represents the variance explained (R²).

As can be seen from this table there are no significant predictors for the communication dimension. The only contribution that is marginally significant is the use of workbooks. When it comes to gaining insight into the strategic problem, the data suggest that in particular the open character of the discussion is important, i.e. the more the discussions have an open character the more insight is gained into the problem. On the other hand, when it comes to building commitment, the presence of an outside facilitator seems to be an important factor. The more the participants think that the facilitator contributed to the overall success, the more they think that commitment was created during the proces. Finally, shared vision seems to be particularly fostered by a visible projection of the constructed causal diagrams by the group.

Conclusion and discussion

As we have stated in the beginning the results from this empirical evaluation have to be considered as preliminary. The number of respondents is small and our measurement instruments need to be tested more thouroughly and refined in the future. With these limitations in mind, we can draw some interesting conclusions. First, all four groups seem to recognize that the use of model-building is both important and useful to strategy formation, and most participants think that it is an efficient method. Second, the output of the sessions (in terms of insight into the problem, the quality of the communication, the degree of shared vision, and the level

of commitment) is rather good. When compared to normal strategic meetings it seems that applying model-building is particularly useful for creating insight and a shared vision more quickly, and to improve communication about the problem.

When it comes to the contribution of the various elements it is interesting to note that in the participants' opinion the presence of an outside facilitator contributed most to the overall success. Regression analysis suggests that various elements contribute to different outcomes. The presence of an outside facilitator seems to be helpful to foster commitment. The visible projection of causal diagrams helps to build a shared vision, whereas the open character of the discussion is essential to create insight.

Certainly, these results have to be considered with some care, and will have to be tested more rigorously in the future.

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