An exploration of the added value of Systems Analysis and System Dynamics for assessing the importance of innovative concepts

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1. Introduction

When a problem is first encountered, the information is normally quite unsorted and disorganized. Often we are presented with a mixture of issues, problems, symptoms, worries, complaints, proposed mechanisms and fragments of solutions (Haraldsson 2005). In order to make sense, it must be sorted, organized and structured. Facilitated system thinking offers a systematic methodology through which all this information can be organized to arrive to an explicit and clear definition of the problem at hand and its determining causes. Accordingly, this methodology proves particularly rewarding for the analysis of multidisciplinary, multi-stakeholder and/or complex problems.

Participatory or multi-stakeholder approaches in which government officials, interest-group representatives and experts work together to find solutions to complex problems (understood as problems in which the nature of the problem is uncertain and the stakeholders appear to disagree on required outcomes) is fashionable, and by now often required as component of 'good governance'(OECD, 2011). Various types of formats have been developed to guide these participatory settings (Ridder et al. 1995). Nevertheless, it seems that in practice a lot of the sessions converge around discussions, without making the understanding of the system and the effectiveness of potential solutions as perceived by the various participants explicit.

At the same time, research projects are commissioned to provide more insight in the effectiveness of potential strategies. This research often involves simulation models, which requires choices on the modelling of the system itself, the input to the model and the processing of the output. For participatory decision-making it is important that participants understand, or at least trust, the way the system is modelled and the assumptions made, agree on the relevant input and feel that the output gives them information on the effects on their interests.

We argue that there is currently a gap between what is discussed in the participatory settings and the knowledge generated through substantive studies. We believe that the application of system dynamics and systems analysis tools, particularly in the form of Group Model Building can help reduce this gap. In this paper we investigate the potential of this technique in the field of innovation management. This is done by making an evaluation of the System Dynamics component of a participative methodology to evaluate the potential of innovative ideas called the 'Storm Methodology', which has been developed recently for the Dutch Ministry of

Infrastructure and Environment. The Storm Methodology is further introduced later in this paper.

System dynamics and system analysis have been around since the 1950s. Since the 1990s a tendency developed to apply these methods in participatory settings known as 'Group Model Building' (see e.g. Vennix 1999) and 'Team Learning' (Senge 1990). Nevertheless, the application for the management of a corporate innovation portfolio and for the decision-making on the feasibility of particular innovative concepts seems rather new. When dealing with innovative concepts, the aim is the search for significant improvement instead of solving existing problems.

This first evaluation is meant as a first step towards the development of software tools particularly geared towards facilitating group model building processes; in particular for innovative concepts. To this end, we are interested in the characteristics that such tools should have in order to best facilitate the participatory process. To identify these characteristics we require answers on two questions:

1. To what extent perceive participants the application and joint development of system models as an added value?
2. What factors are perceived to contribute most to this added value?

This paper aims to give preliminary answers to these questions through a limited survey among participants in sessions of the Storm Methodology. After a discussion of the approach used and the results, we will briefly return in the discussion to how this informs our ultimate question: What are the required characteristics of computer tools to facilitate the joint development of system models?

2. Method & limitations

Sessions organized for the Storm Methodology in December 2011 and February 2012 provided an opportunity to observe group model building and to investigate how participants perceived the application of system dynamics tools, in this case in particular Causal Loop Diagrams. The next section further explains the Storm Methodology. We evaluated two sessions in which two different innovation proposals were analysed: 'National Water Monitoring Network' and 'Carbon Fibre Bridge'. The session for the 'National Water Monitoring Network' differed from the standard Storm Methodology, because it considered multiple possible innovations related to a large problem, instead of focusing on one specific innovation. For our evaluation of the perceived value of system dynamics this deviation does not make a difference.

To evaluate the perceptions of participants to the sessions, we developed a questionnaire based on literature on the added value of system dynamics. The literature review focused on the use of System Dynamics as facilitating the development of shared perceptions of the functioning of the system and the impacts and value of potential system interventions.. An overview of derivation of main factors influencing added value based on literature is available in the subsequent section. The questionnaire is included as Appendix A to this paper. Note that the questionnaire was originally circulated in Dutch, the native language of the participants.

The questionnaire was circulated among participants of two sessions dealing with different proposed innovations, and different groups of participants. In the first session (National Water Monitoring Network), the questionnaire was distributed only among participants from the Ministry of Infrastructure and Environment, for testing of the questionnaire. This group had 12 participants, of whom 3 filled out the questionnaire In the second session (Carbon Fibre Bridge), the questionnaire was distributed to all participants. The second group consistent of 15 participants, 5 filled out the questionnaire. Based on these two sessions the questionnaire is further improved and can be used for future evaluations of Storm Sessions.

We realize that the number of respondents concerns a very small set of data from which no generalized conclusions can be drawn. Also, we realise that the way participants evaluate the application of system dynamics will be influenced by both their role in the session and the format and conduction of the larger Storm Methodology. However, we think the findings are useful as a preliminary result that will form the basis for future evaluations and can guide us in the development of a computer tool to support this type of sessions.

3. The Dutch Corporate Innovation Program and the Storm Methodology

3.1. Positioning the Storm Methodology

The Storm Methodology has been developed for the executive organisation of the Ministry of Infrastructure and Environment – Rijkswaterstaat (RWS) - in order to support their Corporate Innovation Program in the assessment of the potential value of innovative concepts at an early stage. This methodology has been developed jointly by Deltares and Copernicos Groep.

Referring to the stage-gate model of Cooper (1990), which defines various stages that innovations should go through before the gate to the next stage can be opened, one should position it within the second stage: building the business case and plan, which precedes the actual development. According to Cooper, essential steps to be taken are scoping and building the business case. In the end, one should have assessed the technical, financial and managerial feasibility of the concept and be able to draft a project definition and a project plan.

The trigger for the development of the Storm Methodology was the realisation that many innovation projects of the corporate portfolio skipped this second phase and started as (physical) pilots, without clear objectives and insight in the critical factors for successful implementation of the innovation. Hence, significant financial resources were being spent, without a preceding assessment of its potential and scalability. To counter this trend, RWS decided to make a distinction between concepts and projects based on the stage of development and to treat them differently within their innovation management policy. Concepts are required to undergo a Storm Session in order to assess their potential value, feasibility and applicability. Projects are considered to be in a more developed phase and therefore focus is given to the testing of the proposed technologies and processes in physical pilot projects.

Within the Storm Methodology innovative concepts are central. The concept is x-rayed during the Storm Session, which can be compared to a pressure-cooker session. The added value of the Storm Methodology is that together with the stakeholders, experts and idea-initiators a common and shared view is created with respect to the potential of an innovative concept. The

outcome results in an advice on possible actions, and a set of scores for the concept on different attributes, like economical value, certainty, urgency and scalability[1]. Furthermore, the Storm Methodology can also be used for portfolio management, since different scores are attributed to the concept, which makes it comparable to other concepts in the innovation funnel.

3.2. Description of the Storm Methodology

The Storm Methodology is composed of the combination of three different techniques:

1. Stakeholder value mapping with a focus on the specific interest of a stakeholder relative to the implementation of the innovation. The importance of a certain interest is determined by scoring each of these interests or outcomes of interest. Each participant has the right to bring out three votes. The top 3 to 5 outcomes of interest are selected as central goals of the innovative concept and are used as point of departure for the following steps of the session.
2. The Group Model Building or System Analysis part. This departs from the top 3 to 5 agreed outcomes of interest and works them out into an overall System Diagram and the corresponding set of causal loop diagrams. More details on this element will be described in section 3.3.
3. Value scan: the system model resulted in certain key-factors, which are of influence on the outcomes of interest. The value scan composes a quick cost-benefit analysis and makes use of multi-criteria analysis. The key-factors should be quantified to asses their scope and relevance on the economic potential. During this phase the return on investment and the break-even point are calculated. Since it is difficult to assess a not realized innovation, methodically bandwidths are used. This means that the Storm Methodology generates a minimum and a maximum potential value; the real value will be somewhere in between.

A Storm Session is a session that like a pressure cooker accelerates the ripening of innovative concepts and therefore adds to their robustness. The aim is to increase the efficiency in the use of innovation funds by evaluating at an early stage the chances of success of a proposed concept. During these sessions, idea-owners, experts and stakeholders come together to explore the core of the concept. The session is facilitated by a supporting team consisting of a facilitator and two model builders. Based on this information, the management of the innovation program will take a well-considered decision on whether the concept fits the portfolio and how to proceed with the further development of the proposed concept. The outcomes are also of great value for the further shaping of the project proposal in a realistic manner.

The main results of a Storm Session are an overview of stakeholder values and key factors (called leverage points) that determine the effects of the innovation on the (natural/infrastructure) system and its successful implementation. The participatory nature of the session ensures that all participants share these findings; which may also increase their support for the implementation of the concept.

[1] It should be noted that this is a limitation in the method. Currently, there is no sound method of assessing the attributes. It is partly done by scoring during the session.

The following roles are represented during a Storm Session:

- Idea owner or promoter, who also could be project leader within RWS
- Cluster Manager who selects the concepts with enough potential and strategic fit to enrol for the Storm process.
- Stakeholders
- Experts in the different disciplines that play a role in the innovation and its success
- Facilitator
- Method specialists; an economist carrying out the Cost Benefit

The duration of a Storm Session is normally a full day, preceded by a Quick Scan (with two members of the facilitating team and the idea owner). When possible the preparation for the Storm Sessions also includes a 2 to 3 hours working session of the System Analyst with two people who know the innovation well and have an overview of the aspects that play a role in its success.

3.3. How is SD applied in a Storm Session

During a Storm Session a System Diagram (including a set of causal loop diagrams) is built of the system before the introduction of the innovation (current situation) and of the system after the introduction of the innovation (new situation).

The System Analysis is always realized after the Stakeholder Value Mapping. Once all the values of the different stakeholders have been mapped, indicating the priority they assign to each of them and their preferences or the direction in which they would like those values or criteria to change, the System Analyst asks the participants to think of a proxy or operational measure for the most important of these values at stake.

In this way a number of key performance criteria or outcomes of interests are formulated, which are situated at the right side of the System Diagram. Participants are asked to name the factors that influence these performance criteria. In this way each of them is worked out backwards to draw the whole chain of causal relationships that explains the influence of a certain external factor or measures on the final performance of the system.

Once the System Diagram for the current situation is ready, participants are asked to identify the factors on which the innovation has an impact and to indicate if this impact is expected to be positive, negative or unknown. It is important to document if differences of opinion arise at this point and reflect these difference on the diagram. With the help of participants, additional factors and mechanisms introduced by the innovation are also drawn. Making use of the final System Diagram, a group discussion is facilitated on the uncertainties introduced by the innovation and on the trade-offs or new dilemma's posed by it. Often, innovation are expected to not only have positive effects on the performance but also negative ones.

Based on this agreed list of performance criteria and effects, the value analyst proceeds to make an estimate of the added value of the innovation together with the group.

4. Analyzing the added value of systems analysis – insights from the literature

Different authors highlight different benefits of the application of system dynamics in general as well as in group settings. Rouwette *et al.* (2002) carried out a meta-analysis of published group model-building applications to evaluate the usefulness of system dynamics and identify the factors contributing to this success. They distinguish outcomes at individual, group and organizational level, as well as outcomes regarding the model itself. The main outcome they find is that group model-building contributes to learning. Their findings support the statement that participating in modelling is an important factor in achieving learning (p32).

Winch (2000, p15) discusses three dimensions to validate of the application of systems modelling: substantive (technical content or perceived representativeness of the models), constructive (process effectiveness or learning by participants), and instrumental (outcome or final utility of the project or intervention validity). He argues that it depends on the purpose of the application whether high scores are required on some of the dimensions while for that particular purpose low scores can be accepted on other dimensions. If, he continues, the building of consensus is the main purpose, the constructive element is the most important. In such cases it is also not necessary to quantify the results.

Vennix (1999) mentions three reasons for involving the client in model-building processes: 1) to capture the required knowledge in the mental models of the client group, 2) to increase the chances of implementation, and 3) to enhance the clients learning process. Within this process, the use of diagrams Vennix considers useful to: 1) add rigour to the analysis and group discussion, 2) help to identify feedback loops and potentially understand behaviour, 3) put the problem on one sheet of paper, 4) serve as a so-called group memory in Group Model-Building sessions.

Whether or not models should be used for a quantitative assessment is an issue of discussion among system dynamics authors. The non-quantitative, conceptual use, also referred to as 'soft use' is nowadays largely claimed to be able to provide benefits by itself. Some authors even argue that simulation of system dynamics models can be misleading, because of the necessary simplifications included in the model. Proponents of quantitative modelling point out that it is dangerous to draw conclusions on the dynamics of a system that are solely based on diagrams (Vennix 1999).

The reported outcomes can be grouped in five categories:

1. Increased individual understanding
2. Increased shared understanding of system and interests of stakeholders
3. Improved quality of decision-making
4. Increased support for final decision
5. Group memory to be used in subsequent sessions.

Because we evaluated only the usefulness in a single session (two different sessions, but no follow up session on the particular concept), we excluded the fifth point from our questionnaire. Nevertheless, it is an important point for further development of the Storm Methodology because the model can also be used as a reference in monitoring the project during next stages. With regard to the other four points our approach has been to ask for each type of benefit whether the benefit itself was perceived, and which factor was believed to have provided the most important contribution to achieving this benefit. We specified four factors for this purpose: 1) the diagram itself, 2) the way in which one could contribute to the modelling, 3) the interaction within the group, and 4) the possibility of simulating the model to obtain quantified results. The fourth factor was asked in relation to decision-making only. The benefits and factors are summarized in Table 1.

Table 1. Factors and benefits

Benefit / Factor	Individual understanding	Group shared understanding	Decision-making	
			Quality of decision	Support for decision
Resulting diagram				
Own contribution				
Group interaction				
Possibility of simulation for result quantification				

5. Preliminary results - Outcome of the survey administered

5.1. Introduction of the concepts considered in the Storm Session

The National Water Monitoring Network measures water level, discharge, currents, waves and meteorological data in The Netherlands. Moreover, the Network disseminates the astronomical tide in the Dutch tidal waters. Two innovations to this Network were evaluated in January 2012 using the Storm Methodology: 'Measurement with the use of Models' and 'Simplifying measurement stations'.

In this case a system diagram of the system -before and after the proposed innovations- was drafted before the session by the system analyst and the input of two experts. These diagrams were used as a basis for the analysis facilitated during the Storm Session.

The concept Carbon Fibre Bridge aims to use carbon fibre as alternative material to steel and concrete. Carbon fibre has already been used for pedestrian passage. The innovation would be to use it also for larger constructions. An unknown material is often not the favourite alternative of designers and procuring authorities, hence efforts must be made to make the material more known, possibly through trainings and pilot projects. Furthermore, during the Storm Session it became apparent that the production costs of fibre are an important key factor for making it applicable; they should be significantly reduced. The implementation of the innovation involves a change in the collaboration in the field of planning, procurement and construction.

Possible profits are believed to be achieved in: 1) The foundation construction, which can be much lighter; 2) A longer lifetime in comparison to traditional materials as steel and concrete; 3) Reduced maintenance, due to less coatings and easier handling; and 4) Reduced nuisance: during installation and maintenance.

In this case the system analysis during the Storm Session started from scratch and focused only on the situation after the introduction of the innovative concept.

5.2. Analysis of the results

A scale of 5 points has been used all throughout the questionnaire; where 1 stands for little, low or even negative, and 5 for much, high and (very) positive. The questionnaire was filled in by 3 participants in the National Water Monitoring Network Storm Session and by 5 participants in the Carbon Fibre Bridge Storm Session.

The results are the following:

- All assigned a middle to high value (five assigned a 3 and three a 4) to the contribution of CLD's to their (own) understanding of the system and the effects of the proposed innovation.
- When asked which of the following three factors contributed the most to this increase in (own) understanding (a. Resulting diagram, b. Own contribution to the process of building the diagram or c. Group interaction during the building process) two of three respondents chose as explanatory variable the resulting diagram. This question was not asked to the Carbon Fibre Bridge group.
- The most important new insights mentioned are:
  For the National Water Monitoring Network:
  1. *The (side) effects of changes in certain components on the rest of the system was sometimes a real eye opener!*
  2. *Structuring the choice between the aspects to be further studied and the dependency relationships between factors, thereby making the process of deciding what you really want to achieve objective and explicit.*
  3. *Insight in how to ensure consistency, and on the basis of which criteria we will assess the effectiveness and efficiency of an innovation, even if still only qualitatively.*

  For the Carbon Fibre Bridge:
  1. *Insight in the crucial role played by production possibilities and the limitations these posed on the implementation of the technology.*
  2. *The fact that people lay back or do not carry on with the implementation of this innovation, while being aware of the significant added value of it.*
  3. *Insights in the distribution of interest within RWS and the obstacles introduced by standard work procedures, such as the framework contracts.*
- Lower values were assigned to the contribution of the technique to the group understanding than to the personal understanding (two assigned a 4, four assigned a 3 and two a 2). The majority of the participants agreed that the most important factors influencing the understanding of the group are, in order of importance:
  1. Group interaction during the building process
  2. Resulting (qualitative) models

- Most of the respondents agreed on the significant added value of CLD's to the quality of the decision making process. Of the 8 respondents, one assigned it 5 points, five assigned to this aspect 4 points, one a 3 and a single respondent a 2. When asked about the most important factor contributing to this benefit, opinions are divided. While two of them see the resulting qualitative diagram as main factor, two of them believe it is the group interaction during the building process that matters most and two value above all the possibility of simulating the model to obtain quantified results as the main factor. Differences may be explained by the different roles they represent; while idea owners may be interested in the resulting qualitative diagram that assist them in explaining outsiders the core of their innovation; cluster managers may be more interested in the possibility of using the resulting model to simulate and generate quantitative results.
- Except for one respondent (who assigned it 1 point), the contribution of the technique to generate support for the implementation of the innovation was evaluated as middle to high (four assigned it 3 points, two 4 points and one 5 points). Interesting is that for the National Water Monitoring Network session, all agreed that for the achievement of this benefit, the most important factor is the resulting qualitative diagram. This last question was not posed to participants of the Carbon Fibre Bridge session.
- When asked about what was for them the most important of the possible (desired) results, their answers show a great variation. They could mark up to two of the following options:
    1. Individual insight – two votes
    2. Shared perceptions – three votes
    3. Quality of decision making due to implementation of the model (qualitative or quantitative system model) – three votes
    4. Increase in support for implementation – four votes

  The difference in priorities may reflect again the differences in roles; while a cluster manager may be mostly interested in the quality of decision making, a particular stakeholder may be interested in his/her own insights.
- When asked about their preferences on the application of the technique; their responses were:
    1. begin completely from scratch (1 vote)
    2. begin with a basic model with a number of indicators and factors; on the basis on which they can react and develop further (4 votes)
    3. begin with a complete model to which they could react (3 votes)

  Summarizing, they all agreed on the need to start with a basic or even a complete model (seven out of eight); but with the condition that this basic model should be sent in advance to participants with a good explanation of the technique and the meaning of the different system elements and symbols.
- The efficiency of the technique in comparison with other methods often applied to similar projects was valued high in general. One assigned it 5 points, three assigned it 4 points, three assigned it 3 points, and one filled in that his score was yet to be decided; probably based on the resulting report of the session.
- The majority of the respondents would choose again to apply this methodology. A few answers follow:
    1. Yes, because in a relatively short time lots input and insights are gained and processed.

2. Yes, but starting with a an introductory document sent in advance to participants; which would include the System Model, and an explanation on how the diagrams can be read.
3. Difficult to say because I have seen only one example in a non-representative setting2.

It can be concluded that participants agreed on the added value of the methodology and its relative efficiency. The concrete findings about which aspects could be tuned in its application during the group session have been incorporated in the requirements formulated for a possible computer tool application for the Storm sessions.

6. Conclusions and recommendations

Summarizing, what do the results tell us in answering our two research questions? Firstly, to what extent perceive participants the application and joint development of system models as an added value? Based on the survey administered to Storm Sessions participants on the added value of system dynamics, we can conclude that the use of system dynamics in general is considered to have added value.

Secondly, what factors are perceived to contribute most to this added value? The participants indicate the group interaction during the building process and the resulting qualitative model as the most important outcomes. These two had a significant contribution to their individual and collective understanding of the system. In working with System Dynamics models, some participants would prefer to start with basic models prepared in advance, with the condition to receive them before the meeting in order to become familiar with the model. The question remains whether all participants will take the time to prepare for the session and read the material sent in advance.

6.1. Possible solutions offered by interactive software applications

The dilemma to start from scratch or with a given basic diagram that ensures focus on the group discussion may be solved by the possibilities offered by an interactive software application like a touch table, a smart board or by the use of tablets. A pre-built model can be quickly re-built during the session while asking participants for their agreement or adjustments on specific components. Adjustments can easily be incorporated in a flexible tool.

These applications are meant solely as support and not as replacement of the facilitation process of group model building activities. They are therefore an enhancement of the already existing facilitation toolkit. Important to take into account is the fact that the facilitator should be familiar with the tools used during the group model building exercise. Vennix (1999) argues that 'group facilitation is important, because, as is frequently overlooked, the interaction process affects the quality of the outcome and thus the process may be considered equally critical as the content or method. Therefore, the tools and methods used should enhance the interaction process made possible by the facilitator and not reduce it by any means.

[2] The National Water Monitoring Network case has been indeed considered by the Storm team as somewhat different from the average innovation project for which a STORM session will be facilitated.

6.2. Recommendations: design requirements for a supporting tool

What do these results mean for the development of a (software) tool to support the facilitation of group model building processes, in particular for innovative concepts? What are the required characteristics of computer tools to facilitate the joint development of system models? What do participants need to achieve a common understanding on the dynamics of the innovative concept? In addition, how can the facilitation process help herein?

Based on the experience on applying System Dynamics to build a conceptual model of the system (before and after the introduction of the innovation) with groups of 8 to 12 people, with no previous experience with the technique, we recommend the following requirements:

- There is a need to develop a basic Diagram (and set of CLD's) of the System with 2 to 3 experts in advance; in order to ensure a certain level of aggregation, consistency and focus during the Storm Session
- At the same time this built set of CLD's should only serve as a reference, and should not be directly presented in full to the group, since the group may:
    - Feel intimidated by the complexity of the graph
    - Need time to build understanding of the different categories of system components (external factors, measures or instruments, outcomes of interest, etc) and the meaning of positive and negative causal relationships
    - Not know which causal relationship they should or could challenge and therefore
    - The process of building a common framework becomes less transparent and may put at risk the main value of SD and participative modelling techniques: to create consensus and build a common language.

6.3. A possible design of the required supporting tool

Considering the above, the proposed application could look like depicted in Figure 1. The facilitator and/or model builders manage this tool and guide the participants through the protocol. Participants can follow and give input, based on the group dialogue.

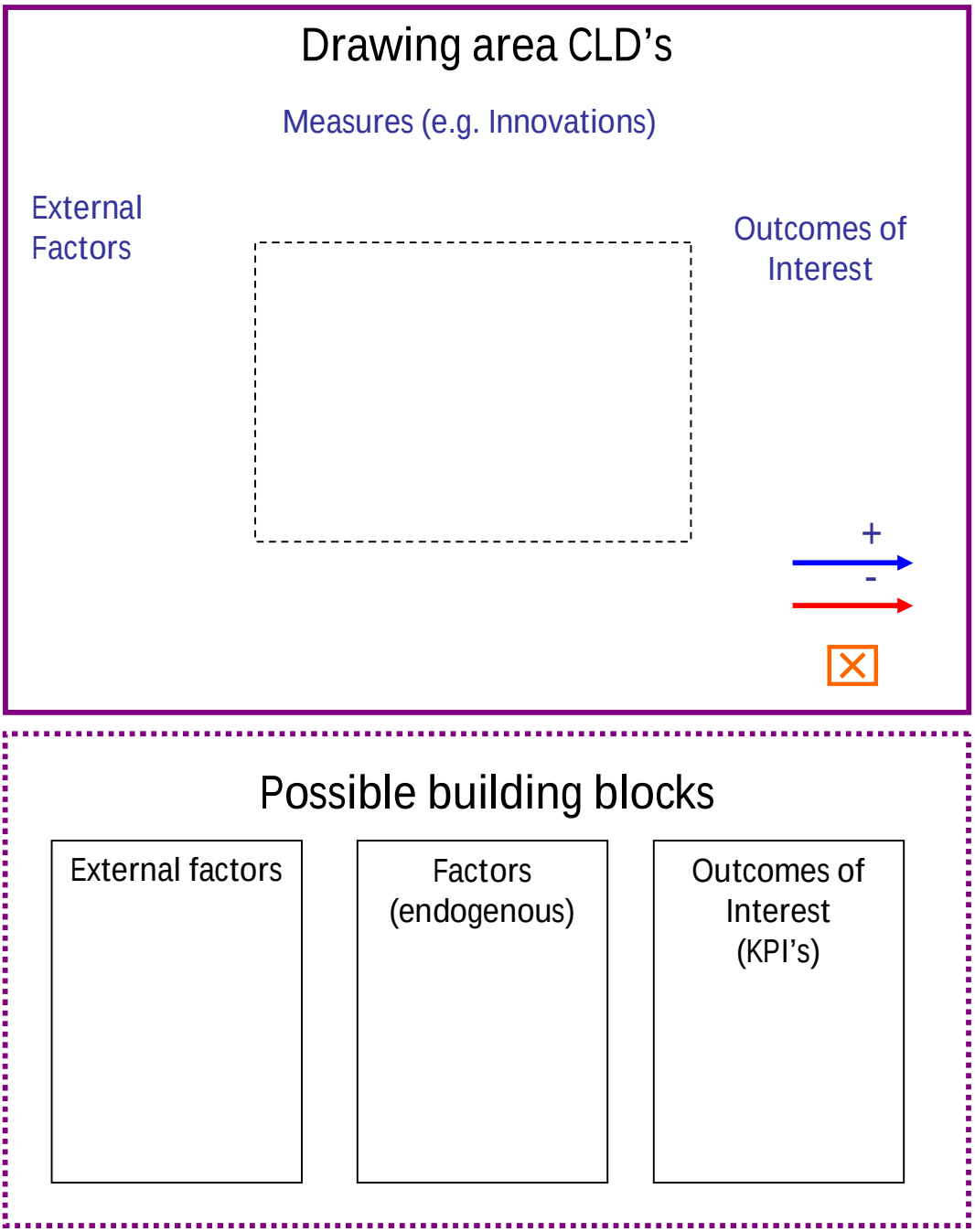

Figure 1. Alternatives shown on the screen of a possible touch table application for GMB

The tool can support the Storm Methodology by following the next steps or protocol:

1. A draft System Diagram and set of CLD's of both (before and after innovation) situations will be built in advance with 2 to 3 experts
2. During the group session only the names of the factors (corresponding to different system components) will be given for inspiration
3. Participants will interactively (with the coaching of the facilitator) bring the existing blocks – or add new ones- to the drawing area, as they all together adopt this factor.

The facilitator will encourage them to start with the Key Performance Indicators or outcomes of interest, and go backwards. This will be done first for the current situation. By following these procedures they do not only validate as a group the resulting diagram but also learn gradually to differentiate between the different system elements; endogenous and exogenous factors (eventually classifying the different components).

4. In parallel, they may add the causal relationship between the factors adopted on the drawing area; assigning a positive (blue arrow) or a negative sign (red arrow) or a question mark, in case the effect is not known. Eventually a * sign can be assigned to the links for which opinions diverge.
5. Participants may add a "comment" on a factor or link in order to document any additional quantitative or qualitative information they consider relevant for the discussion.
6. Once a System Diagram of the current situation has been built; a graphic story is presented about the innovation. This can be done as an animation on the touch table based on the pitch of the idea promoter.
7. Participants then review the System Diagrams of the current situation and are asked if as a result of the introduction of the innovation:
    a. causal relationships have changed?
    b. some factors have become less relevant? (Delete)
    c. new factors have been introduced? (also here a new set of factors coming from the previous CLD's prepared with experts could be proposed)
8. Based on this discussion and resulting insights, they all decide (fill in) on the following issues:
    a. Key factors or leverage points of the system,
    b. Main uncertainties introduced by innovation.
    c. Main positive and negative effects or key dilemma's or trade-offs introduced by the innovation.

6.4. Concluding remarks

This paper presented the results of a limited exploration of the extent to which System Dynamics is perceived to provide added value to participatory sessions. Our main aim with this evaluation was to gain insights on whether the development of a software tool to support facilitated group sessions would be worthwhile to pursue and which would be its ideal characteristics. Although the scope of the evaluation was very limited, we have concluded that a flexible tool that allows for interactive expansion and adjustment of system diagrams can be very useful. Such a tool would be different from existing tools such as Powersim, which are more targeted at expert users and quantification. We have presented our first ideas for such a tool and will continue to evaluate participants perceptions while developing this tool in a way that it presents an added value to the joint investigation and evaluation of complex policy problems.

In this continued effort we aim to pay additional attention to a number of specific issues:

1. All assessments of impacts of potential measures will carry some uncertainties. For innovations it can be expected that these uncertainties are particularly large. We aim to pay specific attention to how facilitators and participants deal with these uncertainties in working with system dynamics

2. How will participants respond to the use of a touch table? And what will this mean for the further development of the touch table application? In future evaluations we will consider how we can combine surveys with participant observation.
3. Andersen and Richardson (1997) introduced 'scripts' – well-defined elements of group model-building sessions that can be combined to program specific session. The Storm Methodology can be considered to form a set of scripts as well and can be further developed into clearly defined and exchangeable elements. The role of the touch table in these scripts can be further elaborated.

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Appendix A: Survey administered

"Research into the added value of systems analysis"

Introduction

Purpose of this questionnaire

Within the framework of an explorative research project by Deltares, we aim to investigate what the added value is of using 'system dynamics' methods and techniques, such as system model sand Causal Loop Diagrams (CLD's), in processes in which experts, stakeholders and policymakers work jointly on problem defintions and potential solutions to problems.

Your answers to this questionniare will help us increase our understanding of the added value of systems analysis (through the use of Causal Loop Diagrams).

What will we do with the results

When the Causal Loop Diagrams and system models are found to indeed have an added value, we will apply this approach more frequently and develop the method further. Your answers will help us to shape subsequent phases and to develop the right products.

1. What is your role in the Storm Session?
   - o Stakeholder
   - o Expert
   - o Idea-owner
   - o Clustermanager
   - o Facilitator
   - o Methodological specialist

2. Did the application of Causal Loop Diagrams have little or much added value for you to obtain a better understanding of the system (the effects of the proposed innovation)?

	1	2	3	4	5		Factor that contributed most to a better understanding
							o Resulting diagram
Little	o	o	o	o	o	*much*	o Contributing personally to the Construction of the diagram
							o Group interaction in constructing the diagram

If your understanding increased, what were the most important new insights you obtained?

……

……

3. Do you think that the application of Causal Loop Diagrams had little or much added value for the group to obtain a better understanding of the system (the effects of the proposed innovation)?

	1	2	3	4	5	
Little	o	o	o	o	o	*much*

Factor that contributed most to a better understanding

- o Resulting diagram
- o Contributing personally to the Construction of the diagram
- o Group interaction in constructing the diagram

4. Do you think that the application of the Causal Loop Diagrams will have little or much added value for improved decision making?

	1	2	3	4	5	
Little	o	o	o	o	o	*much*

Factor that contributed most

- o Resulting diagram
- o Contributing personally to the Construction of the diagram
- o Group interaction in constructing the diagram
- o The possibility to simulate the resulting model and quantify the impacts

5. Do you think that the application of the Causal Loop Diagrams will have little or much added value for increasing the support for implementation of the innovation?

	1	2	3	4	5	
Little	o	o	o	o	o	*much*

Factor that contributed most

- o Resulting diagram
- o Contributing personally to the Construction of the diagram
- o Group interaction in constructing the diagram
- o The possibility to simulate the resulting model and quantify the impacts

6. What is for you the most important desired result?

- o Individual understanding

O Shared perceptions

O Quality of decision-making by application of the model

O Increased support for implementation

7. Which of the following aspects should be given more attention??

O Construction of the model

O Use of software during the sessions

O Simulation of the model/quantifying the results

8. What would be your preference in the application of system models?

O Starting with a blank sheet of paper or blank screen and building the model from scratch

O Starting with a basic model with a number of indicators and factors, to react upon and elaborate

O A complete model to react upon

9. How do you evaluate the efficiency of these methods in comparison with other methods for a similar problem?

	1	2	3	4	5	
Low	O	O	O	O	O	*high*

10. Would you choose this same approach in a new situation?

Why would you choose this (and do you have a specific application in mind?):
.....

Why would you not choose this (and can you indicate what an alternative approach could be)? :
.....

11. Did you, in general, experience your participation in the session as a positive or negative experience?

	1	2	3	4	5	
Negative	O	O	O	O	O	*positive*

What was the most important factor that influenced this experience?