Developing a logistics strategy through participative business modelling

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Introduction
It has long been common knowledge that developing an effective operations strategy can be a highly complex undertaking[1,2]. This complexity is of both a technical nature and an organizational nature. In the past decades, numerous methods have been developed to support companies in the design of their operations strategies[3-6]. All these methods excel in tackling the technical complexities at hand. Unfortunately, it often turns out that, when put to practice, the implementation success of these technically refined methods leaves much to be desired[1,2,5,7,8]. An analysis of such unsuccessful implementations shows that the main causes of failure are related to the organizational complexities of operations strategy development[9]. These “conventional” methods often require a considerable degree of “expert consulting”, in which line management participation tends to be low. And low management participation leads to a lack of ownership of, and commitment for, the resulting strategy, which leads to low implementation success, regardless of the technical qualities of the proposed operations strategy.

In this article a method is presented, called PBM or participative business modelling, which addresses these organizational complexities through intensive, but highly structured line management participation in the operations strategy development process. But PBM is more than a team-building or process facilitation technique; rigorous analysis and extensive modelling is conducted to ensure technical correctness of the proposed solutions, and refined group knowledge elicitation techniques are used to optimize time investment of participating line managers. This article describes a case study in which PBM was applied successfully to develop a logistics strategy.

The participative business modelling method
Group model building
Strategic issues are always highly complex, are always “problem messes”[10]. At the core of PBM lies the notion that people can gain a great deal of insight into such a problem mess by modelling it – that modelling a strategic issue always implies learning about the strategic issue. In PBM, a group of managers facing a strategic issue develops a model of that issue in a series of group model-building sessions, facilitated by one or more experienced modellers/ process facilitators. Modelling in PBM moves gradually from very informal,
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qualitative, and conceptual models to more formal, quantitative simulation models. PBM contains techniques and guidelines for this whole modelling process. Table I shows a number of these techniques.

A toolbox of different techniques
In PBM, models are not limited to the conventional mathematical modelling techniques from operations research/management science (OR/MS); rather, PBM consists of a whole toolbox of different techniques from various origins, carefully combined into a synergetic mix:

- Systems modelling techniques, originating mainly from the fields of system dynamics and “soft OR”[12-14].
- Knowledge elicitation techniques, originating from various disciplines within the social sciences[15,16].
- Basic management consulting skills, with a strong emphasis on a process consultation – i.e. a non-expert consulting – attitude[17].

As such, PBM can be seen as one of a number of “business modelling” approaches to management consulting that have come forward in the past ten

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Table I. Main PBM project phases and techniques employed per phase (see [11])
years, ranging from Checkland and Scholes’ soft systems methodology[18] to Eden’s strategic options development and analysis[19]. All these approaches share a systems perspective and an emphasis on a process consultation attitude. They all create conceptual, graphical models with managers in group sessions, thereby structuring not just the issue at hand but also the process of discussing, learning and creating group consensus.

PBM differs from these techniques in its foundations in the system dynamics methodology, which enables easy quantification of these conceptual models – an ability which is especially useful in strategic operations management issues, where quantified analyses are almost always feasible and expected. On the other hand, PBM appears to be less suited than these other approaches in dealing with politically sensitive issues, with groups of participants that do not share a common goal or a willingness to collaborate, as some of the other case studies have shown[11,20].

Design guidelines

The techniques mentioned above are all fairly generic and have been well described in the existing literature of the various fields involved. The main added value of the current research project may be that it generated a number of design guidelines on how to employ these techniques, which give guidance to the modeller/consultant on three different levels:

- Level 1: How to employ a specific technique in certain circumstances.
- Level 2: What particular mix of techniques to employ, depending on these circumstances.
- Level 3: When to use or not to use the PBM method as a whole - the indications and counter-indications for the method[21].

The research method

Conceptual research model

PBM has an implicit theory of how effective strategic decision making is best achieved. This theory, illustrated in Figure 1, is also the conceptual research model for the PBM research project. As will become clear from its description, PBM is developed for a wider range of strategic issues than solely issues in operations strategy.

An effective strategic decision ultimately means a decision that will improve business performance. For performance to be improved, the decision-making process must have some immediate implementation results in an organization. If any implementation results are to be obtained, two conditions will have to be met simultaneously: first, the problem must be correctly analysed, which in terms of our theory means that model quality will have to be OK. And second, there must be a sufficiently strong level of organizational support for this analysis: the most brilliant analysis will end up in a drawer unless it enjoys an organizational platform. Every organization will arrive at these two conditions given infinite amounts of time and resources. However, in the real world both time and resources are limited. Therefore any consultant wishing to facilitate
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Decision-making processes, needs to establish an effective process of decision making, one that is speedy, focused, and encourages good communication.

**Design-oriented case study research**

The main research objective then becomes to develop and test a method that:
- delivers high quality solutions for strategic issues;
- can rely on solid organizational support;
- achieves the solutions in a fast and focused process.

This makes the PBM project design-oriented research: the main research objective is to design a method. For such research projects, multiple case studies are an ideal research design[21,22] because one has to observe the phenomenon in its real-world context (cancelling out laboratory experiments) and study it from close up and in-depth (which cancels out surveys). In the current research project, six such case studies have been conducted in which the PBM method was applied to real-world strategic issues[11]. After each case, the performance of the method was evaluated and improvements were made in the design of the method. This improved version of the method was then applied in the next case. Of the six cases, the first case study was clearly of an exploratory nature[23]. In case studies 2[24] to 4[20] most of the design improvements were made. In cases 5[25] and 6[11] the version of the method had been more or less “frozen”. These cases were being performed primarily to evaluate the performance of this final version of the method.

![Diagram of strategic decision making and implementation](image-url)
The cases differ greatly on a number of relevant characteristics, such as project size, type of industry or problem type, so that our theory described above can be tested under widely different conditions, as is appropriate in multi-case design[22]. Nevertheless, the case studies could not be selected specifically with this in mind but were commercial projects, which the author happened to be able to conduct in his capacity as consultant with the consulting firm for which he was working part-time during this research project. This article presents results from the third case study.

The case study
The client company and its strategic issue
The client company in this PBM case was an American pharmaceutical start-up company, wishing to set up operations in Europe. At the start of the project, a European office had just been established, and the nucleus of a management team was operational. The main product of the company was a life-saving drug, to be distributed to hospitals throughout Europe. The issue at stake was the design of an appropriate logistics strategy and structure for the European distribution of this drug.

The main technical complexities in this case were:
- the extremely time-critical nature of the illness in question, which required on-site delivery within eight to 12 hours throughout Europe;
- numerous other clinical, marketing, financial and legal constraints to be taken into account;
- lack of existing operations and lack of existing products with similar logistics requirements.

The main organizational complexities in this case were:
- a brand-new management team, geographically dispersed and with highly pressed time schedules;
- the removal, early in the project, of the European general manager, who had been the original project sponsor;
- the disappointing test results for the drug, made public halfway through the project, which made the issue of setting up European distribution far less urgent than it had been originally, and thus management interest in the project considerably lower.

Project synopsis
For this company a PBM project was conducted by the author in his capacity as a management consultant. Project duration was three months. The project as a whole proceeded globally according to the generic phasing described in Table I. First, structured interviews were conducted with management, next, several modelling workshops were conducted with a core project team of the logistics manager, the financial manager and the operations manager and various other participants. In the quantitative modelling phase these conceptual models were
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Enhanced with quantitative data, and several simulation models were developed in this phase. In the fourth phase of knowledge dissemination, management interacted with these simulation models in additional modelling workshops, where management assumptions about the future performance of the logistics system were systematically made explicit, challenged and refined.

Project deliverables
Designing a logistics strategy requires multiple, interrelated decisions. Originally, six areas that needed further investigation were defined. Of these, the author was actually involved in three. Each of these three sub-projects had a clearly defined deliverable, discussed below.

A causal map of the main strategic trade-offs
As its goal, the first sub-project had to identify and make explicit the many strategic trade-offs that had to be considered in the logistics set-up. Marketing, clinical research, finance, logistics, the juridical department, manufacturing—all these functional areas had their own primary goals and considerations. Sometimes these coincided with one another, but often they did not. Therefore, trade-offs had to be made, preferably explicitly, and preferably by all parties concerned. To make these trade-offs clearly visible, a causal diagramming technique was employed. Figure 2 shows a causal diagram of one of these strategic trade-offs which was created during one of the modelling workshops.

One of the main objectives in the initial period of product launch was a marketing objective: to increase market awareness by having physicians use the drug successfully, and getting word-of-mouth publicity because of this. From this perspective, it would be best to target as many European hospitals as

![Figure 2. A causal map of a strategic trade-off](image)
Design guidelines for the European depot network
A second sub-project was to develop, on the basis of these trade-offs, practical design guidelines for the European depot network. At the time, the client company had hardly any existing operations in Europe, so the depot network had to be designed from scratch. What kind of network would be appropriate? The options varied from one central European depot to hundreds of small depots within selected hospitals, and any number of depots in between.

To answer this question, a quantitative model was developed in a system dynamics simulation package. The crucial quantitative relationships in this model were modelled in close interaction with the experienced logistics manager of the company. Frequent use was made of so-called “graphical functions”. Figure 3 shows an example of one such graphical function.

The simulation model provided quantified answers to trade-offs between transportation costs and depot network costs. In the final evaluation, six additional qualitative evaluation criteria were also used to determine the optimal depot network structure.

Design guidelines for the European call centre
The third sub-project aimed to provide design guidelines for the European call centre which the client company wished to set up to control the distribution process. Here incoming calls for the drug would be handled and drug shipments would be processed. Of course such a call centre was non-existent at the time. Therefore a simulation model of such a call centre was developed in a discrete-event simulation language with animation facilities. This model provided answers to questions such as:

- How many physicians do we need? How many clinical research assistants?
- What opening hours will provide acceptable delivery times for the drug? Should we, for example, be open at night?
- What would be the gains in performance and costs of an automated request handling procedure?

This model was developed more or less in expert mode, but was explored at length in a so-called “learning wheel” workshop[26] with management. In a “learning wheel” workshop, management expectations of future system behaviour are systematically made explicit and compared with model
behaviour. If differences between the mental model of the manager and the computer models are discovered, an analysis of the causes of these differences is conducted and one of the two models is adjusted.

**Project evaluation**

Qualitative evaluation research

Several of the objectives PBM tries to achieve may be described as “soft”. Hard criteria to evaluate effectiveness of the method, such as “X per cent lower inventory levels”, or “Y per cent higher profits”, are not used, which makes evaluation difficult. To overcome these difficulties, so-called qualitative data analysis has been used in the case evaluation process[22,27]. The main materials for this analysis are the texts of the post-project evaluation interviews that were conducted with the main participants in the project. These texts have been searched for statements referring to elements in the conceptual research model described above. These statements have been interpreted and aggregated to an overall score. These statements and the overall scores once again have been presented to selected members of the client organization for additional feedback. After all six cases had been analysed in this manner, cross-case analysis was performed to enable analytical generalization[22] of findings.

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**Figure 3.**

Road versus air transport as a function of the average distance from hospitals to depots

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Note: This graphical relation was drawn in a session with the logistics manager. It shows the percentage of air shipments for increasing average distances between drug depots and hospitals. The simulation package converts this graph into relevant numerical values. External research providing strong external confirmation of this graph, which was merely the result of two expert “guestimates”, was obtained only after the actual project itself had ended.
These findings are reported in [11]; here we will limit ourselves to the findings from this particular case study.

From high-level variables to indicators
The three objectives of the PBM method have been described above as variables in the research model. These are, however, still fairly generic. What does it mean to have “a good organizational platform” for a decision? Therefore these three high level variables, as well as the high-level variable “implementation results” are split up into more detailed indicators. These are shown in Table II.

From indicators to high-level variables
First a separate table was made for each of the indicators, in which all the statements made by participants referring to this indicator had been brought together. From these statements, an overall score per indicator was determined. Next these indicator scores were combined for each high-level variable. Once more an overall score per high level variable was obtained, as becomes apparent from Table II.

From indicator scores to causal explanations
So far analysis has merely been descriptive. But the ambitions in this research were also to find explanations as to why these particular scores were achieved in this particular case. Therefore, a similar procedure has been followed for three additional categories of project contingencies from the research model, which also have their own sets of indicators: problem contingencies; organizational contingencies; project design elements.

In the evaluation interviews, respondents drew causal relationships between these indicators and the indicators shown in Table II. These causal

<table>
<thead>
<tr>
<th>Process effectiveness</th>
<th>Model quality</th>
<th>Organizational platform</th>
<th>Implementation results</th>
</tr>
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<tbody>
<tr>
<td>Focus: +</td>
<td>Completeness: +/-</td>
<td>Commitment: +/++</td>
<td>Decision implementation: +/-</td>
</tr>
<tr>
<td>Speed: -</td>
<td>Thoroughness: +</td>
<td>Consensus: ++</td>
<td>Operations performance: NA</td>
</tr>
<tr>
<td>Communication: ++</td>
<td>Usability: +</td>
<td>Ownership: +/Confidence: +/-</td>
<td>Insight: ++</td>
</tr>
<tr>
<td>Overall: +/-</td>
<td>Overall: +</td>
<td>Overall: ++/High levels of commitment and consensus inside core team. Others: no data available</td>
<td>Overall: + Implementation delays through external developments. High levels of learning</td>
</tr>
</tbody>
</table>

Table II.
Overall evaluation of project performance by participants
relationships were then analysed, and provided most of the clues for the explanatory case analysis that is presented next.

The overall case results then are:

(1) Process effectiveness was considered low because of:
   - low participation of management outside core project team;
   - much repetition in workshops because of frequent changes in group composition;
   - low use of inter-session workbooks to summarize previous results.
   **Counter-argument:** there was good focus and effective communication within the core project team.

(2) Decision quality was considered high because of:
   - good and complete listing of all the issues and viewpoints;
   - thorough quantitative analysis with simulation tools.
   **Counter-argument:** there was low marketing input and little external analysis during the project.

(3) Organizational platform was considered high to very high because of:
   - high levels of commitment and consensus within core project team;
   - intensive participation and open communication in workshops.
   **Counter-argument:** there is insufficient data on commitment of the non-core project team members.

(4) Implementation success was considered high because of:
   - implementation of the findings in actual operations;
   - high levels of insight gained and organizational learning established;
   - the start of a follow-up PBM project with the client company one year later.
   **Counter-argument:** implementation was strongly delayed because of external developments.

**Discussion**

The evaluation results from this particular project have provided valuable lessons, which can be clustered into three groups: lessons for the conceptual research model; lessons for the PBM method; lessons for the evaluation method.

Lessons for the research model

These include:
   - Insufficient involvement means insufficient process effectiveness: process effectiveness was perceived as low (fairly painful for the PBM method,
which focuses on effective structuring of the decision-making process) because of insufficient management involvement in the workshops.

- Insufficient top management support causes insufficient management involvement: early in the project the European general manager, who had been the original project sponsor, was removed. This made it more difficult to ensure full attendance of all of management at the workshops.

- Low problem awareness means low management involvement: any logistics set-up for the company would strongly affect all functional areas, for better or for worse. However, developing such a set-up was seen by most managers as the primary responsibility of the logistics manager, not as theirs. They had their own primary areas of responsibility; so perceived problem urgency, or problem awareness, was not high on average, and became even lower after the disappointing intermediate test results had made short-term implementation of European operations unlikely.

- Afterwards, the “soft” project results have the strongest perceived impact: the original project goals were fairly “hard” and technical. Afterwards, these hard and technical results were available and satisfactory, but the project participants indicated that the main benefits for them had been “soft” ones such as open communication, learning and team building.

Lessons for the PBM method

These include:

- Use workbooks to provide inter-session feedback: workshop speed was perceived as slow because of the degree of repetition that was in them. This repetition was necessary to bring the session members that had been absent at the previous session(s) up-to-date. This could also have been accomplished by the use of so-called “workbooks”[11,26]. In PBM workbooks the main results of the previous session are summarized and feedback on these results is elicited. Such workbooks have since then become a successful standard element of PBM projects.

- Low data availability is not a counter-indication for PBM projects: in this project there were no data available from existing company operations. Also, the product and its logistical demands were unique. That means that there was no existing product against which to benchmark. Also, there was little time to conduct external empirical analysis, so modelling remained mostly limited to “mental experiments” by the project team. However, several outside sources have since then confirmed the correctness of the results obtained by these internal analyses.

- Discrete-event simulation can be quite well-suited for the implementation of qualitative system dynamics models: the design recommendations for the European call centre were based on experiments with a discrete-event simulation model. This quantified discrete model was based on a
qualitative conceptual system dynamics (and hence, continuous) model – no technical difficulties were encountered there.

Lesson for the evaluation method
The lesson here was:
- Conduct evaluation interviews with stakeholders that did not participate in the project: the organizational platform for the project findings was very high within the group of core participants. However, there were more stakeholders to this project than just these three key members. These non-participating stakeholders were not interviewed. Hence, no data regarding their commitment to the project findings are available. Therefore it is advisable to interview at least some members of this group (of course the best option would be to get all stakeholders involved in the project itself).

Conclusion
Much has been said in recent years about the need to address process-related issues in operations strategy development[2]. Of course the best experienced practitioners have been doing just that for quite some time already. A fairly recent development is the emergence from academia of more formal support frameworks for both content and process-related strategy issues[eg. 11,28,29]. In itself it should not be too difficult to provide such process support, since the basic strategy process material has been around for quite some time now (see [9]). Rather, the main challenge appears to be in achieving a close-knit integration of both process and content support. Group modelling approaches such as the one introduced in this article seem eminently suited for this purpose, for their forte is that they help structure both the problem and the process.

References


