Success Factors of e-Collaboration in Business Process Modeling

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Abstract. We identify the success factors of collaborative modeling of business processes by a qualitative analysis of the experiences of participants in group modeling sessions. The factors and their relations form a preliminary theoretical model of collaboration in modeling that extends existing models. The insights from this guided the improvement of a group modeling method and tool support which are in turn relevant outcomes of the design part of this study. We show in field experiments that the new method outperforms the conventional one.

1 Introduction

The purpose of this paper is to identify factors of a modeling method that have an impact on the quality of the model and the modeling process. For this purpose we draw on the existing literature on electronic collaboration and extend and refine the factor models that can be found there. To do this, we study collaborative modeling sessions and interview the participants to elicit possible factors. As we assume that participants can make valid assertions about modeling we have to show whether these factors are indeed relevant. We did so by incorporating them into a modeling method and accompanying tool to see whether using the factors really improves collaborative modeling. In detail we proceed as follows.

We describe the results from 4 case studies and eight controlled field experiments conducted at four organizations. The aim of the case studies is to find factors that determine the success of business process modeling sessions. This is done ex post with the help of semi-structured interviews with the participants of such sessions. The details of that procedure and its results are described in section 4. We identify eleven factors and their relations in the areas facilitation, motivation, group & team, and support. The factor model is provided in section 5.

The sessions were done to improve a process modeling method and a supporting tool. Method development was driven by the success factors (6.2). Section 6 also shows the lessons we learnt with respect to the necessity of a co-evolution of method and tool and the current status of the process modeling method.

The field experiments aim to validate the tool-supported method by comparing it to the conventional method used in many organizations. This is done by a quantitative analysis of questionnaire data. The results are reported in section 7. The factor model itself is not validated but as the factors controlled method development, the validation

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of the latter is an indication of the usefulness of the factor model. In the following two sections we describe related research and the research approach that we have taken.

2 Related Research

One relevant area is that of electronic meeting systems (EMS). They are computer systems designed to support electronic meetings (also called group support systems). Some collaboration factors were identified in the Focus Theory of Group Productivity [1] that refers to cognitive processes in group members. EMS's have been found to decrease the demand for **attention** and increase **productivity**.

The proponents of electronic meeting support claim that EMS's have a positive effect on the outcome of meetings. There is general consent to that but there is some debate as to the conditions for successful EMS use. Most researchers think that an EMS has a moderating impact on the process, which then improves the output [2]. We agree and put the focus of our research on the modeling process.

There are two mechanisms by which EMS's can make a difference over face-to-face meetings: **anonymity** and **simultaneity**. The former means that utterances cannot be attributed to their originator. It is assumed that this will lead to additional ideas that people would otherwise not have felt comfortable to share. Simultaneity means the possibility of all team members to utter their ideas at the same time. In conventional meetings only one person can speak at a time which leads to air time fragmentation and thereby to a loss of ideas.

Both anonymity and simultaneity are supposed to moderate group process gains (such as more objective idea evaluation, learning from others, etc.) and process losses (such as air time fragmentation, production blocking, conformance pressure, free riding, evaluation apprehension, etc.). These process characteristics are assumed to determine outcome factors such as efficiency, effectiveness, satisfaction, consensus and so on [3].

Experimental results were inconclusive [4] but case and field studies showed the contributions of EMS's in reducing meeting time and increasing meeting productivity [5]. The application of EMS's to group modeling has also been studied [6-8] with similar results.

The problem with EMS's is that they only support divergent processes but process modeling also requires convergent processes such as **filtering** and **integrating** alternatives. These aspects are addressed in the COMA approach (COllaborative Modeling Architecture).

Another closely related research area that can contribute success factors is that of model or modeling quality. E.g. [9] suggests that modeling is a mapping procedure where specific choices for the representation of reality have to be made along the way. We consider modeling rather as a social construction process, though, which offers many more choices. [10] proposes to the use of cognitive mapping techniques as a quality factor. So the method itself can also be a factor. We have restricted our attention on the factors within a method. This way we can engineer in the long term an optimal method instead of making a choice between arbitrary given methods.

3 Research Methodology

Process modeling (or modeling, for short) is a collaborative activity that involves a number of stakeholders possessing the required knowledge about the process or goals of the organization. Although modeling is in principle always collaborative we call it collaborative modeling because we want to stress the importance of a true and close collaboration of the participants in group modeling (we come back to this later). In this section we present the theories that have an impact on collaborative modeling and the approach we have taken to conduct the research.

3.1 Relevant Theories

As modeling is a collaborative activity it is natural to first take a look at the literature that deals with collaboration in general. In the section on related research we have already pointed out the major works that deal with this topic. But here we consider only such literature that provides some theoretic framework for explaining the factors that determine the quality of collaboration.

An early milestone of collaboration was the work of Osborn on brainstorming [11]. He claimed that the critical factors for successful idea creation are **quantity of ideas** (divergent production), **absence of criticism** (to stimulate ideas), encouragement of **unusual ideas** (out of the box), and **idea combination**. Although these factors seem logical enough, subsequent research has not found clear evidence that brainstorming provides better ideas than other techniques. This ‘contradiction’ was solved by [12, 13] who found that the advantages were thwarted by **production blocking**, **evaluation apprehension**, and **social loafing**.

Production blocking means that a person that explains his idea distracts other group members from producing own ideas. Evaluation apprehension [14] means that participants are reluctant to share their ideas because they fear social punishment. Social loafing refers to a group member spending little effort relying on others.

One of the most elaborated theories on collaboration is Focus Theory by Briggs [1]. It studies the **individual effort** a participant spends on collaboration assuming that it can be spent on communication, deliberation, and information access, but not at the same time. Productivity in one area therefore limits the effort that can be spent on the others. The overall productivity depends on high productivity in all three areas which constitutes a kind of a vicious circle. Briggs did intensive behavioral research to concretize the factors that have an impact on individual effort.

In short his model relates the factors perceived difficulty of task, desired certainty of success, perceived effort required, perceived effort available, self efficacy, desire for goal, individual effort and group productivity. Briggs mentions some motivational factors that are important for successful collaboration: desired certainty of success and desire for goal. These intrinsic output-oriented factors are not sufficient for successful process modeling, though, as the output (model) is not desirable for the participants.

We have therefore turned our attention to the literature in psychology dealing with collaboration. There a distinction is made between intrinsic and extrinsic motivation, i.e. motivation that originates in us and motivation that is imposed on us by people in our environment. In our study we consider both of them. In our study we have also elicited further factors and classified them.

Another source of knowledge that for our research is Consensus Building Theory [15]. It specifies a few basic rules for collaboration that should lead to consensus, which is of particular importance in process modeling. Among them are the use of a professional and neutral facilitator, the presence of representatives of all stakeholders and the existence of ground rules to guide participants (i.e. a method).

3.2 Research Approach

Our research mainly follows the principles of design science and combines it with action research [16, 17] to study the collaborative creation of process models. Design science is a framework that emphasizes the development and improvement of artifacts in cycles, in our case a method and a tool.

The development of the artifacts was based on business needs derived from an empirical studies and applicable knowledge from theory [18, 19]. Validation and further improvement of the artifacts was studied in [20] in the form of a comparative experiment.

The purpose of this paper is not so much the relevance cycle which is documented in [18, 20], but the rigor cycle, i.e. the contributions to the knowledge base. These contributions take on the form of important factors and the way they are related to each other. The general factors in e-collaboration were derived from relevant theories as outlined in 3.1. Special factors for e-collaboration in modeling were derived from a qualitative analysis of an interview study (see 3.3, 4) and confirmed in quantitative comparative experiments (see 7). The result is a qualitative model of these factors.

3.3 Data Gathering

The data was collected in four case studies that were carried out in a sequential order so that the lessons learned in one could be used to adapt the methodology and/or tool before going into the next one (design cycle). The cases were done (in this order): at a large psychiatric hospital (PH), a large insurance company (IC), a medium-sized bio-engineering laboratory (BL), and a large public administration (PA). In total we did 5 modeling sessions lasting between 0.5 and 1.5 days. We did a to-be model for all cases except IC, and an as-is model for PH and IC. The teams had between 7 and 12 participants that usually worked in groups of two.

Data was gathered in the form of ex-post qualitative interviews with participants that were normally performed directly after the respective session but not later than on the morning after. The interviews were semi-structured but we allowed interviewees to elaborate on a point or to mention other issues. We also asked questions that came to our mind while listening to the respondents. All 37 interviews were conducted by the same researcher. The major questions were:

- Which factors are relevant to achieve a good model?
- Which factors are relevant for making modeling worthwhile?
- Which factors are relevant for making the output more desirable?
- What are the advantages of COMA over conventional modeling?
- What are the advantages of conventional modeling over COMA?

The answers from the respondents were coded and specific factors were taken up in the list of relevant factors when they were mentioned by at least half of the group members in a least 3 of the 5 sessions. We grouped the factors into facilitation, motivation, group & team, and support factors. For further details see section 4.

4 Data Analysis

The interview data was analyzed as described above. The resulting factors have been categorized into 4 categories: facilitation factors, motivation factors, group & team factors, and support factors. The following sections are devoted to each category and discuss the results from the interview in the light of relevant theories.

4.1 Facilitation Factors

Consensus building theory mentions that the facilitator has a significant impact on the collaboration output. He should therefore be professional and neutral. Professionalism can easily be ensured by hiring a consultant who does that work on a daily basis. But that does not automatically ensure that he is neutral, even if he has been recruited externally, i.e. not within the targeted organization. **Facilitator bias** is always present because the facilitator has to translate the input from the participants into a process model. His perceptions will therefore influence the way in which the model is built.

With conventional techniques such as brown paper this can hardly be avoided as they leave the overall responsibility for the model to the facilitator who consequently plays a role that is too dominant. Reducing facilitator dominance can be achieved by **participant involvement** in model building. This also frees facilitator resources that to be used elsewhere and removes the facilitator bottleneck that prolongs modeling sessions. But according to conventional wisdom this is impossible because modeling requires a highly skilled modeling expert.

Our experience in the cases has shown the contrary to be true. Unskilled people can develop complex business process models after having played a modeling game for about an hour. These models are not always 100 % perfect but they usually require very little re-working, mostly to fix poorly structured layouts.

From this we conclude that facilitation has to be seen from a different perspective: the facilitator should not elicit knowledge and transform it into a model, but he should rather support people in modeling themselves and help them with the **integration** of the different views. This approach was tested in many cases and was rated by the participants as being both a better way of modeling and delivering a better result (see section 7).

4.2 Motivation Factors

A fundamental problem with collaborative modeling is the fact that participants of such an exercise have no intrinsic motivation for the result itself. Most people are not interested in the model and do not see a need for it. But extrinsic motivation implies the risk of shirking (i.e. underperforming when not noticed). Consequently intrinsic motivation seems more promising, but instead of on the model we have to focus on the modeling process. **Motivation for modeling** is therefore a key factor. A powerful intrinsic motivation is that of gaming. The use of gaming for modeling has already been suggested by [21].

People gladly do a tough job if it comes in the disguise of a game. Think of PC gamers who spend days and nights without monetary reward just to reach the next level. In terms of the modeling process we therefore need to increase the motivation for modeling with the help of gaming elements. We have done so by introducing a **competition** that consists of scoring models followed by the nomination of a winner (i.e. the best model). In practice this means that models are not only developed by participants but the "players" also score one another.

The latter can also be interpreted as a form of extrinsic motivation. In psychology this is called social comparison. If I know that I will be judged by my peers I will put much more effort into model development because nobody wants to be a loser.

4.3 Group and Team factors

For practical reasons and to improve group productivity, the whole group is split into teams of 2. For the whole group it is paramount that members have complementary knowledge. The obvious reason for this is that it increases the overall unique process knowledge of the team and hence the richness of knowledge they can contribute to the model. Together the group members should possess all required knowledge.

But there is also a more subtle mechanism at work that requires the division into smaller, **complimentary** teams. Team members with complimentary, but overlapping knowledge are likely to have some conflicting views on the process. Solving these conflicts with the help of a constructive dialogue between two team members is much easier than in the larger group where the air time is much more fragmented, which prolongs conflict resolution. There is also a higher risk for the conflict to escalate when even more different opinions collide.

In short, minor conflicts are solved more effectively and efficiently in a small team and will then not escalate to the group level. Fundamental problems will surface to the group level in the consolidation phase, which is the forum where problems of this kind need to be addressed. This facilitates **consensus** building.

But dividing a group into small teams is not only a way of introducing two conflict handling layers to speed up the modeling process. Discussions in a small team also stimulate the team's creativity (four eyes see more than two) and thereby the richness and quality of their proposal and of the integrated model.

Another important factor is the **degree of participation**. It indicates the relative number of group members that are actually active in a session. A higher degree raises model quality by making models richer but lowers consensus by adding views.

4.4 Support Factors

When it comes to the support we mainly think of some computerized tool that can increase the motivation for modeling and the model quality. We have found four areas in which support is needed. They are discussed in the following sub-sections.

Modeling support

First of all we have to take a look at modeling itself. If participants are supposed to model we obviously need some computerized tool support for them as a number of paper versions could hardly be integrated in a structured way. This means that the tool, called COMA, has to provide a model editor that is simple enough to allow unskilled modelers to draw their business processes without the need for major education.

We have used a reduced version of the activity diagrams of UML that provides only the most basic elements: activities, simple flows, decision points, parallel processes, actors (as swim lanes), and notes (for comments and issues). Any other modeling language (e.g. the Business Process Modeling Notation, BPMN) would work just as well as long as the participants are not drowned in too many features of the language.

In a simple modeling game that goes through all the steps of the modeling procedure but uses a simple process known to everybody (getting cash from a teller machine) we make the participants acquainted with the language, the tool and the procedure. They learn them as a side-effect while trying to win the prize for the best model (in some cases we actually handed out a small prize, in others the winners were just applauded).

Competition support

Just telling the participants that a winner will be nominated is not enough as an incentive. If, for example, a jury would determine the winner, or perhaps even the facilitator himself, the decision process is not transparent for the participants and they might think that other factors than model quality would influence the decision. This easily leads to a situation of discouragement.

A jury would also be hard to find because the experts in that domain already sit around the table. The facilitator is the worst judge because he typically possesses no knowledge whatsoever about the targeted process (which otherwise is a plus because it makes him more neutral).

We have therefore decided to introduce a scoring of each model proposal by the other modeling teams. After the complete scoring round of all proposals the facilitator shows the whole group the average scores of all teams as bars of different sizes and numbers. This is an exciting moment for the teams as they get to know their own scores and how they relate to the others.

Being judged by their own peers (often colleagues) makes them put as much effort into the modeling as they can, and that is precisely what we want to achieve: the best possible effort by all group members. Nobody can hide behind more active group members as everybody has to deliver a model and every model is scored.

The result of the scoring round, which usually takes ten minutes, is not only a winning team but also a winning model. This will be the basis for all further development as the highest overall score clearly indicates that this model has the strongest support and therefore the best chance of creating consensus. It cannot be taken as the final version, though, as some details might still be missing or misrepresented. This needs to be settled in a consolidation step.

Communication support

Verbal communication is essential in modeling [22] as the process of creating a semi-formal representation is embedded in a natural language conversation about this representation. If the modeling session is organized as a workshop with all participants being in the same room at the same time, most of the conversation can take place in the usual face-to-face manner.

If the group members are physically distributed but still working synchronously, the face-to-face talk can be replaced by a video or teleconference. But many organizations prefer the modeling work to be done off-line (asynchronously) so that the involved employees can do the work at a time that is convenient for them. If the participants are managers it is also very difficult to find empty time slots that coincide in everybody's agenda. This delays modeling work unnecessarily.

There is thus a need for asynchronous communication support. Such technologies do exist, of course, in the form of email or even voicemail but the conversation is related to a specific part of a particular model so the communication support has to be linked to the modeling support.

Information access support

According to focus theory information access is one of the three building blocks of collaboration. Collaborative modeling therefore also needs to give participants access to vital information. The most important information is of course stored in the model itself, but open issues expressed in natural language are also relevant information.

Both kinds of information should be accessible via a collaborative modeling tool to facilitate distributed and asynchronous work. This means that model proposals of one team can be opened by other teams to look at but also to reuse elements from other models in your own. When it comes to open issues the collaborative modeling tool has to provide a function that allows participants to log written comments with respect to another team's proposal they are currently reviewing.

This is further elaborated in section 6.2.

5 An Initial Model of Factors in Collaborative Modeling

If we summarize the findings from the empirical study we arrive at the factor model that is shown in Fig. 1.

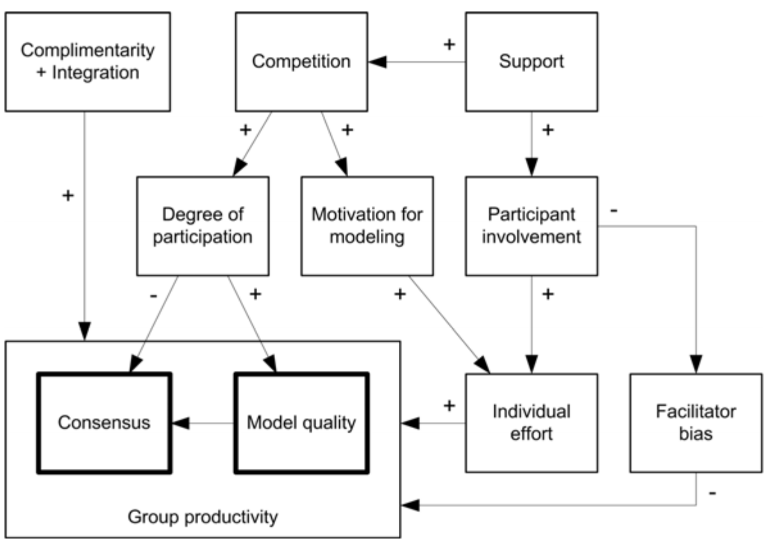

Fig. 1. Our model of collaboration factors in modeling

Please note that the model is not a general collaboration model but restricted to the specific case of collaborative modeling. It is an extension of the existing models that are connected via the variables *Individual effort* and *Group productivity*, which are present in all of them. In our case the latter consists of model quality and consensus, which are both important products of the modeling process.

It should be noted that the factor model is the result of qualitative research. The model needs to be validated in a quantitative study that also determines the strength of the links between the factors. Nevertheless, the results from the qualitative study have allowed us to draw some interesting conclusions and to develop a modeling method and tool that make use of the identified factors in order to improve the modeling process as well as its result, the model.

6 Lessons Learned

The lessons that we learned from the case studies and interviews about the relevant success factors provided valuable input for the development of a modeling method that incorporates these factors. If the elicited factors do have an impact on the quality of modeling and the model then this should lead to a more successful method also. The following sub-sections describe how the method and tool were developed and section 7 compares it to the most common existing method.

6.1 Co-evolution of Method and Tool

The first lesson was that the modeling method strongly depends on modeling steps that some tool can support. But the development of the tool is of course also driven by the requirements of the method. The latter is the normal way of developing methods and tools. But the former needs explanation. Why should the tool drive the method? The reason is that certain method steps cannot be performed (or not efficiently) with conventional tools but require sophisticated tool support that can only be provided by a computerized tool. They might therefore be excluded from the method.

But it is precisely these additional or modified steps that make the method superior to others as seen in a study comparing the COMA method to the conventional method based on brown paper. This is shown in section 7.

The conclusion we can draw from these experiences is that the development of method and tool are so closely related that you cannot separate the one from the other. Instead the design of both artifacts is done together. We call this co-design or co-evolution of method and tool.

We see the tool as an inseparable part of the method which means that an empirical evaluation of only one is not possible. We have therefore set up an experiment to compare the COMA method + tool against the conventional method and tool (brown paper). This is described in section 7.

6.2 Towards a Collaborative Process Modeling Method

Another important lesson told us that the new factors we have identified make it necessary to develop a method that exploits these factors in order to improve both the modeling process itself (in terms of participant satisfaction) and its result (the model).

The method has been developed in a design cycle where we started with the conventional method and an existing modeling tool (UML Pad). We added, modified or extended steps in the method that we thought would implement a certain factor. At the same time we introduced the corresponding functionality in the tool. To check this we have used the modified method and tool in action research to test whether it works and to get feedback on the implemented factor, e.g. Did the motivation for modeling increase? This procedure was iterated factor by factor and so far we have reached a modeling method that contains 7 steps. Modeling is done in teams of 2 people. Each team has a computer with the COMA tool (*factor support*). This tool basically offers three tabs: One for editing your own model; one with the latest version of the group model; and one that allows you to open models by other teams. The facilitator is equipped with the same tool running in facilitator mode and being connected to a beamer that projects the screen content on a blank wall that is visible to everybody.

Step 0:
Introduce participants to the COMA method and tool by playing a simple game of 1-2 hours. Instructions for the game can be found on the Internet, both for the participants and the facilitator (anonymized). The facilitator divides the whole group into complimentary teams of two supported by the responsible process or change manager that knows the group members (*factor complimentary teams*).

Step 1:
Collect activities (as-is) or brainstorm for them (to-be) (*similar to the conventional method*). Each team of two participants enters into the model editor an activity box for each activity labeled with the name of the activity using the usual form *verb + noun*. The time for this step is set in advance by the facilitator who also explains the scope (where does the process start and end) and the granularity (how detailed should the model be, e.g. in terms of a rough upper limit for the number of activities). At the end of the time the teams post their models, i.e. they make a proposal. The facilitator checks that all teams have made their proposals (*factor degree of participation*).

Step 2:
Score the activity model (*factor competition*). Each team opens the proposals of each other team, one by one and gives a score on a scale from 0 to 10. The facilitator has to specify the scoring criterion: E.g. compare the other model with your own model w.r.t. completeness assuming a score of 5 for your own. At the end the facilitator will show the average scores of all teams on the big screen. The model with the highest score is chosen and becomes the new version of the group model.

Step 3:
Consolidate the best proposal (*factor integration*). In this step the best proposal is adapted according to input from the participants. This is similar to model elicitation in conventional sessions but the facilitator here has already an almost finished model available and can concentrate on fine-tuning it. The model is visible on the big screen (and also the facilitator's changes) and participants can discuss in the large group to resolve remaining issues. In most cases there is little work left to do.

Step 4:
Structure the activities (*similar to the conventional method*). The teams copy the final set of activities into their editors and add the control flow and swim lanes (for actors). The facilitator has to set an appropriate time when the teams post their proposals.

Step 5:
Score the process models (*factor competition*). This step proceeds exactly as step 2 but the scoring criterion might be different depending on the particular situation. For an as-is model completeness and correctness are appropriate even here.

Step 6:
Consolidate the best process model (*factor integration*). This step proceeds as step 3. The facilitator helps solve critical issues and improving the layout.

We have now described the method and which of the factors led to which of the steps being affected. What remains to be shown is whether this new method, although it worked very well in the design cases, does really outperform the conventional way of producing models. This is done in the next section.

7 Comparative Experiments

We have carried out comparative experiments at IC that involved 8 groups with a total of 83 members. In each experiment we had the same group model equally sized parts of the same process. The morning session was performed using COMA; in the afternoon the conventional approach was used. This order was chosen to avoid that better scores for COMA could be attributed to the learning curve. Immediately after the afternoon session each participant had to fill out a questionnaire that asked for a ranking of COMA and conventional method with respect to 12 quality categories concerning both the model and the modeling process.

The COMA sessions at IC were performed as described above.

The conventional sessions at IC proceeded as follows. The major tools used are a big brown paper attached to the wall and a number of differently colored post-it notes. In the beginning the facilitator asked the participants for the roles that are involved in the business process and made a swim lane for each of them on the brown paper.

He then asked the group members to name the steps (activities) in the process and wrote each one down on a post-it note that was attached to an empty space on the brown paper, i.e. not in a particular swim lane. When all activities had been named the facilitator would take one note after the other and ask the participants in which swim lane it belongs. It was fixed there in an arbitrary position.

After having placed all notes the facilitator elicited the order of activities starting from the first step. He drew an arrow from an activity to its successor and he also introduced decision points where necessary. As the notes were not ordered within a swim lane the resulting diagram became messy and consolidation of the model proved often to be a difficult and time-consuming task.

After the session and off-line, the facilitator entered the diagram into a professional modeling tool and sorted the activities as well as the arrows to get a readable layout.

The quality categories for our study are based on the ones used in a similar study [23]. They have been adapted to reflect the differences between system dynamics models and business process models.

The respondents had to check the approach that they experienced as superior in each of the quality categories. The conventional method was coded as 0, COMA as 1. We performed the non-parametric χ^2-test to find out whether there is a significant surplus of 0's or 1's in the respective category.

The χ^2-statistic measures the fitness of an observed frequency with a theoretical distribution, in our case a uniform distribution with 2 outcomes (50% 0's and 50% 1's) if the outcome is random. For a degree of freedom of 1 (2 outcomes) and a significance level of 5%.the critical value is 3.84. If χ^2 is lower than that the outcome is random, otherwise it is significant.

The result is shown in Table 1 and Table 2. BP means 'business process'.

Table 1. χ^2 for the first six of twelve quality categories

	More Insight into BP	Quicker Insight into BP	Better Communication	Better Shared View	Quicker Shared View	More Commitment
χ^2	**6.373**	0.301	0.301	**24.398**	0.976	0.590

Table 2. χ^2 for the second six of twelve quality categories

	Quicker Commitment	Stronger Influence	More Ownership	Better Result	Better Way Of Working	More Progress
χ^2	0.108	**41.940**	**18.325**	**22.277**	**28.928**	**11.578**

Significant results are highlighted in bold. Some them also reach a significance of 1%. Out of the 12 quality categories COMA achieves a significant improvement in 7.

The improved categories are:

- More insight into the business process
- A better shared view
- A stronger influence of individuals on the result
- A stronger feeling of ownership of the model
- A better result (model)
- A better way of working
- More progress in modeling

In the other categories COMA scored equally well as the conventional method.

8 Conclusions

We set out to identify the relevant factors for successful modeling in the area of business process modeling. We did so by performing four case studies and collecting qualitative data on the factors by means of semi-structured interviews. While these factors and their relations also form important insights in themselves, the major reason for looking for them was for the purpose of guiding the design of artifacts that support group modeling.

In a design cycle we therefore developed a business process modeling method and a supporting tool. Both were employed in action research in many cases, amongst them the ones of this study, to ensure continuous improvement. To see whether the current artifacts really represent an improvement over existing methods we performed field experiments. In each we used the same modeling group and the same business process to ensure that the modeling method is indeed the only different factor. To exclude a learning curve bias we always conducted the COMA session first.

In seven out of twelve quality categories COMA significantly outperformed the conventional method, while there were no differences in the other five. This also lends credence to the factor model, which we used in building the artifacts. Nevertheless, the factor model cannot be considered validated knowledge yet as a quantitative study has to prove the strength of the identified links.

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