Appendix F: Formulating categories for the content analysis of the expert interview transcripts

Initial categorization

A first point of reference for the formulation of categories for the content analysis was the interview guide, which was compiled on the basis of the three research questions.

RQ 1: What are the key characteristics for the representation of continuous processes?

RQ 2: How do experts evaluate the current usability and comprehensibility of BPMN for continuous processes?

RQ 3: What potential improvements can be identified regarding the introduced extensions?

For this reason, for each interview transcript the interview questions and respective experts' answers were transferred into a table to sort out irrelevant content in a first step. Following the instructions given by [1], the rule set for the steps Z1 to Z4 were applied to the material. Due to the large quantities of material, however, the steps Z1 to Z3 were combined into one. For each step, a set of rules as described by [1] is applied. The first step was the combination of Paraphrasing (Z1), Generalization (Z2) and First Reduction (Z3) in which the experts' statements were reformulated into a simple form and reduced to relevant elements. An example for this step is given in Tab. 1.

Table 1: Z1 to Z3 - Paraphrasing and reducing the material.

Interview Identifier	**Answer**	**Paraphrased and reduced version**
Allrounder 3, P 101	Q4.1, Ex1 - Comprehensibility: "Verständlichkeit. Genau, also man muss natürlich erst einmal die ganzen Symbole sich merken, also was jetzt quasi Abbruchkriterium darstellt, und so weiter. Aber ich finde es gut, dass die Labels mit dabei stehen, also ich würde auch (...), ja, zwischen Vier und Fünf würde ich da geben."	have to remember all symbols, good that labels are included, between 4 and 5

Since inductive categorization was chosen, this initial reduction has been performed for one interview of each group to be able to get an impression from the beginning of the possible categories that can be defined towards the end. For this first round, the following transcripts were selected: Engineer 4, Allrounder 1 and Modeler 4. These were selected due to their completeness, interview language (German) and variance in the order in which the interviews were conducted.

Final categorization

After this initial steps, the second reduction step (Z4) has been performed on these respective transcripts.The reduced statements were grouped together for each transcript based on similar content, or various details were combined into one overarching theme. From these summarized statements and overarching themes, the first categories were finally derived. These formed the basis for further processing of the remaining interviews. Text passages that could not be assigned to any of the existing categories during the processing of the remaining documents were reformulated into a new category. This step created the final categories (Step 6 and 7 described by [1]).

Formulating the categories

For a large proportion of the answers from the transcripts, categories could already be derived on the basis of the interview questions. The questions with predefined point systems are worth mentioning here (Questions 1, 4, 5, 7, 10). However, since the experts did not always give their answers in accordance with these options, but sometimes formulated them openly or did not give any answers at all, the scoring system was translated into the categories "Positive feedback," "Negative feedback", "Neither/Indefinite" and "N/A". Here, "Indefinite" was chosen as well in order to be able to map answers that could not be assigned unambiguously to either a positive or a negative opinion. An example for this category are the indefinite answers to questions 1.3 regarding the importance of temporal conditions for state queries and regulations, "The duration of each S&R combination is limited". These are listed in Tab.3.

Table 2: Ambiguous answers to Q1.3 assigned to "Neither/Indefinite"

Interview Identifier	**Answer**	**Paraphrased and reduced version**
Engineer 4, P 23	"Naja, es kommt immer auf diesen Regelprozess an. Es gibt sicher in Astronomie Regelprozesse, die mehrere Jahrtausende, Jahrmillionen dauern. Da ist es unwichtig. Aber es gibt Regelprozesse, die sehr schnell ablaufen müssen. Ja, dann ist es wichtig. Ich sage einmal, ja, es/ wenn man diesen Regelprozess, ja sich anschauen muss und beurteilen muss, wie schnell muss mein Regelprozess wirken, damit hinten das richtige richtige/ die richtige Konsistenz von Bier herauskommt, oder richtiger Zuckergehalt. Also, sagen wir ja."	Depends on control process, Processes in astronomy are long -> unimportant, quick processes -> important yes
Allrounder 1, P 22	"Das ist eine gute Frage. Ja ich meine, es kommt wahrscheinlich ganz darauf an, was für ein Prozess das ist und wie wichtig das ist, wie lang das her ist. Aber ich schätze halt, dass es wahrscheinlich oft nicht so wichtig ist, ob es jetzt fünf oder zehn Sekunden her ist. Aber ja, wahrscheinlich ist es/ kommt es auf den Prozess darauf an."	depends on what kind of process and how important how long ago, probably often not that important, yes, probably depends on process
Modeler 3, P 14	"Das heißt, sozusagen beschränkt. Ich habe nur zehn Sekunden Zeit, um dann zu reagieren, oder? Okay. Ja, kommt wahrscheinlich auch auf die Art des Prozesses darauf an, oder? Also wie schnelllebig ist dieser Prozess? Das heißt, wie schnell muss ich sozusagen in das System eingreifen können und dann sollte die Dauer wohl schon beschränkt sein. Wäre dann wichtig."	depends on process, how fast-moving is process? how quickly to intervene, then important

Two of the answers listed in Tab.3 conclude with a positive statement, that the temporal conditions are indeed important. However, due to the preliminary reasoning of the experts, all three answers are labeled as "Indefinite" and therefore assigned to the category "Neither/Indefinite".

The remaining questions were open-ended and therefore resulted in open-ended responses. In these questions, the experts were motivated to share their own ideas and thoughts. These include the questions 2,3,6,8 and 9. For the corresponding answers, the use of inductive categorization proved to be successful, as different aspects were mentioned due to the different backgrounds of the experts. Here, overlaps in various questions arose across an interview, so that the answers to various questions could partly be assigned to one category. An example of this is Engineer 4's opinion that direct and indirect acting are not apparent in the models. This opinion can be extracted from two passages. These are listed in Tab.

Table 3: "Direct acting, indirect acting not clear" represented in the transcript

Interview Identifier	Answer	Paraphrased and reduced version
Engineer 4, P 137	Q4.5, Ex1 - Extensibility "(...) Mir fehlen, wie die Messgrößen auf den Regler endwirken. Wie sich der Regler verhält. Ob es ein Direct Acting, Indirect Acting ist. Das heißt, ob der Fehler mit Minus Eins oder mit Plus Eins multiplizIiert wird. (...)"	Values missing that affect controller, how controller behaves, whether direct or indirect acting
P 184	Q5.5, Ex2 - Extensibility “Genau. Also. //I: Okay. // Ich habe in meiner ganzen fünfzehnjährigen Laufbahn noch nie einen PID-Algorithmus programmieren müssen. Weil das meistens Standardblöcke von den SPS-Prozessleitsystem-Hersteller sind. Aber dafür Reglersinn sehr sehr oft umstellen müssen.“	Exactly, never had to program PID algorithm in 15 years Mostly standard blocks from PLC vendor, but often had to change controller-sense (orientation)

Deriving results

After the continuous categorization of the relevant and reduced passages, the resulting findings were summarized in tables and visualized in spider diagrams or bar charts. The bar charts that are not found in the main part are shown here.

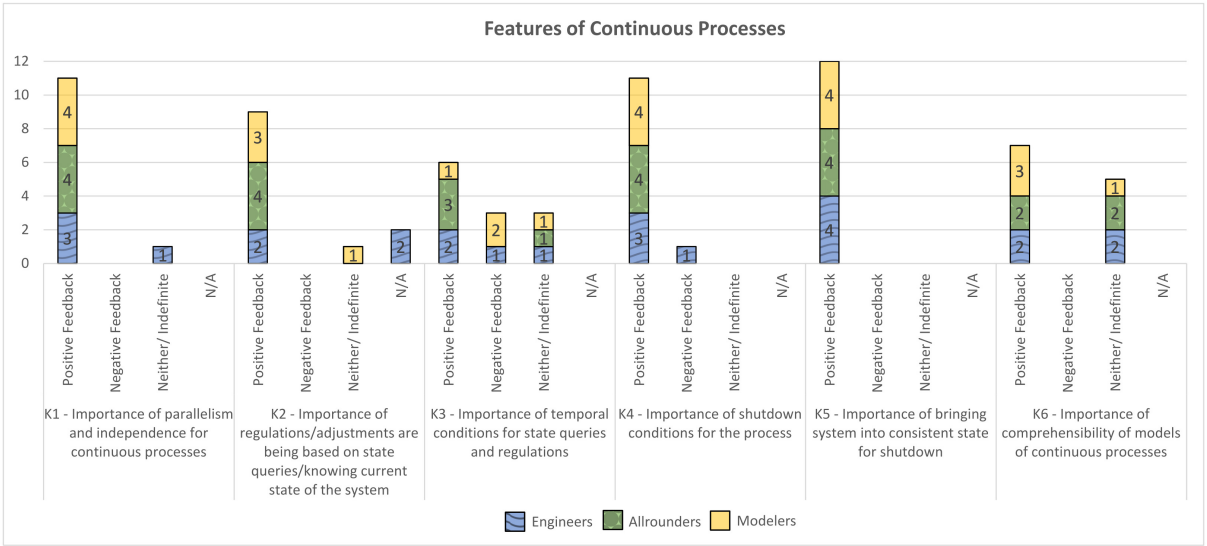

Figure 1: Features of Continuous Processes.

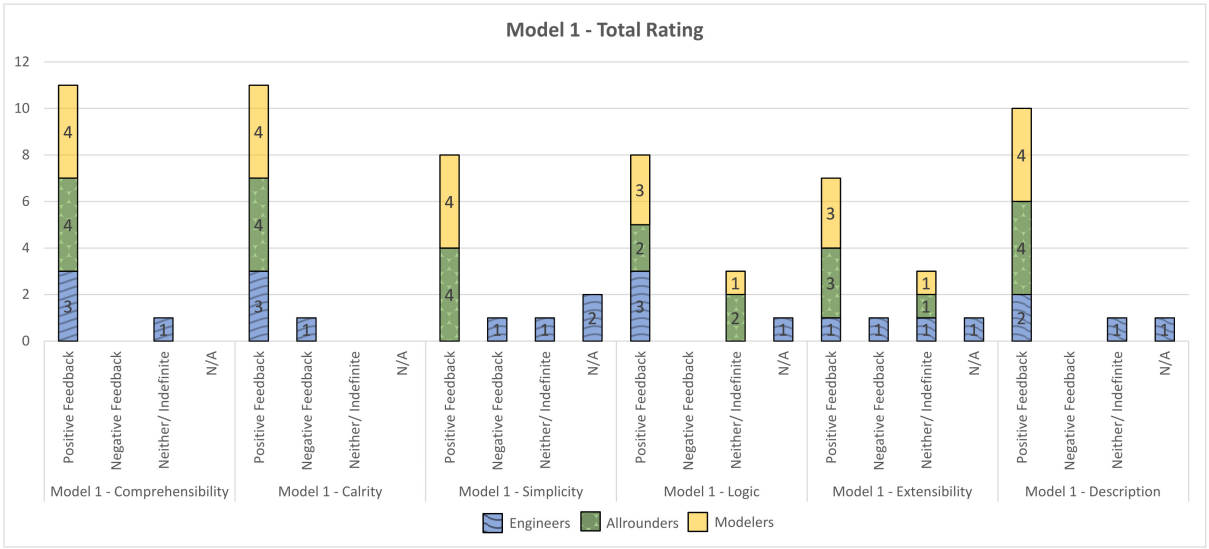

Figure 2: Rating for Model 1.

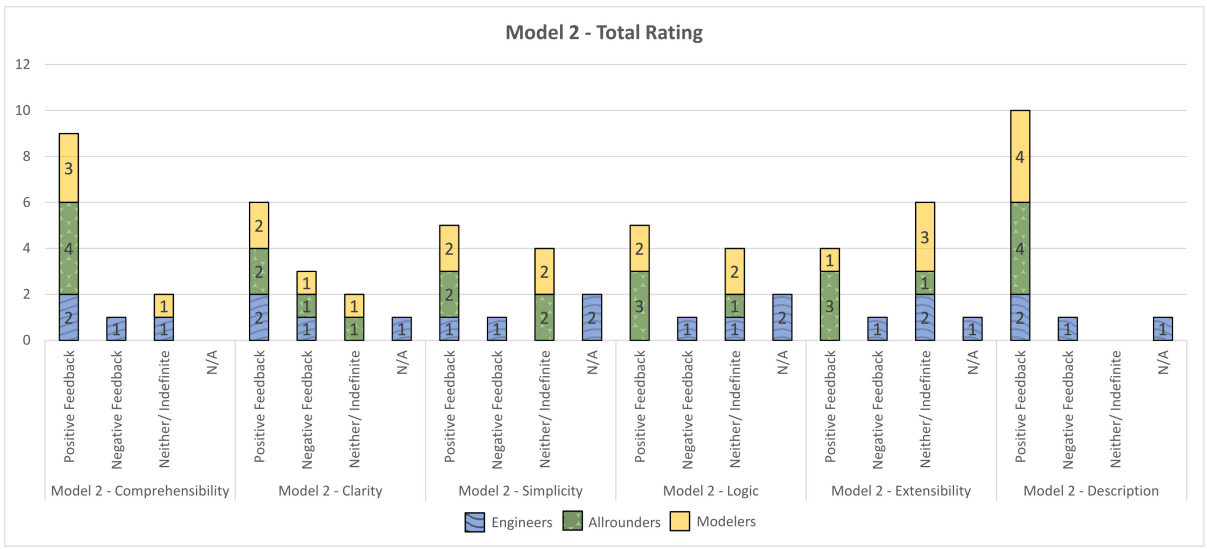

Figure 3: Rating for Model 2.

Figure 4: Usability rating.

References

[1] P. Mayring. *Qualitative Inhaltsanalyse : Grundlagen und Techniken*. Pädagogik. Beltz, Weinheim Basel, 12., überarbeitete auflage. edition, 2015. ISBN 9783407293930.